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ABSTRACT

This second edition contains teacher and student guides for 14 units of instruction in major appliance repair. Each unit in the teacher edition includes some or all of the following basic components: objective sheet, suggested activities, answers to assignment sheets, answers to the written test, written test, a unit evaluation form, teacher supplements, transparency masters, information sheet, student supplements, assignment sheets, and job sheets. (Student units contain the same materials except for teacher supplements, answers, evaluation forms, and transparency masters.) All of the unit components focus on observable and measurable learning outcomes, and are designed for use in more than one lesson. The units cover the following topics: (1) major appliance repair orientation; (2) safety and first aid; (3) fundamentals of electricity; (4) AC induction motors; (5) diagrams and schematics; (6) tools, materials, and test equipment; (7) automatic washers; (8) automatic dryers; (9) automatic dishwashers; (10) garbage disposers; (11) trash compactors; (12) gas ranges and ovens; (13) electric ranges and ovens; and (14) microwave ovens. The teacher's edition also contains the following: information on use of the publication, a competency profile, national competencies, a list of related academic and workplace skills, a list of needed tools, equipment, and materials; and list of 37 references. (KC)

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Major Appliance Repair

Second Edition

Fundamentals of Electricity

Automatic Washers

Automatic Dryers

Automatic Dishwashers

Garbage Disposers

Trash Compactors

Gas Ranges and Ovens

Electric Ranges

Microwave Ovens

Customer Service



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Teacher Edition

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Major Appliance Repair

Second Edition

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**Major Appliance Repair
Second Edition**

Teacher Edition

Table of Contents

Introductory Pages

Forward	v
Acknowledgments	vii
Use of introductory materials	ix
Use of this publication	xi
Competency profile	xv
Instructional/task analysis	xxi
Academic and workplace skills (classifications)	xxxvii
SCANS foundation skills	xxxix
Tools, equipment, and materials list	xlvi
References	xlix

Teacher Pages for Each Unit

Student Pages

Unit 1:	Major Appliance Repair Orientation	1
Unit 2:	Safety and First Aid	15
Unit 3:	Fundamentals of Electricity	49
Unit 4:	AC Induction Motors	97
Unit 5:	Diagrams and Schematics	127
Unit 6:	Tools, Materials, and Test Equipment	155
Unit 7:	Automatic Washers	207
Unit 8:	Automatic Dryers	271
Unit 9:	Automatic Dishwashers	319
Unit 10:	Garbage Disposers	365
Unit 11:	Trash Compactors	385
Unit 12:	Gas Ranges and Ovens	419
Unit 13:	Electric Ranges and Ovens	485
Unit 14:	Microwave Ovens	511

Foreword

Major appliance repair technicians still make good money and are still in demand. That's why *Major Appliance Repair* was redesigned to produce a *Second Edition* that would be even better than the original. This second edition is better because it consolidates microwave oven repair with major appliance repair—it's now two books in one!

Of course, more doesn't always mean better, but in this case, it is better because of MAVCC's new format which produces the lowest cost student materials available. What's more, it provides instructors with added suggested activities that will help them localize materials and motivate students.

With the increase in home building over the past decade, the future looks bright for increased appliance sales of all kinds. That means the future for appliance repair technicians is a bright one too. We think *Major Appliance Repair, Second Edition* provides the training needs that the workplace requires of a professional repair technician.

As you enjoy success with the text, we hope you'll let MAVCC know how you effectively put the materials to work in the classroom. Likewise, we want to know of any problems you encounter. Give us a call at 1-800-654-3988, or check out the MAVCC internet website at <http://www.mavcc.org>

Jean McEntire, Chairman
Board of Directors
Multistate Academic and
Vocational Curriculum Consortium

Clark Harris
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Brent Clever	Whirlpool Corporation	Denver, Colorado

We also thank the many manufacturers who generously granted permission for MAVCC to reprint illustrations and procedures vital to the presentation of accurate training materials. The names of those manufacturers appear as credit lines throughout the text to identify their contributions to our effort.

We especially thank Amana Home Appliances of Amana, Iowa for permission to reprint the excellent color photograph used for the cover of this text.

Use of Introductory Materials

Introductory materials are included in the teacher edition only and contain useful information to assist administrators and teachers in planning for instruction.

In addition to the general information such as the table of contents, the following information is also included:

1. **Use of this publication**—Explains the components of a unit of instruction and how they should be used as part of the teaching/learning process.
2. **Competency profile**—Provides a record of student performance for each task included in a unit of instruction. This becomes a part of the student's permanent records and should be utilized when directing the student toward employment opportunities.
3. **National competencies**—Matches objectives, assignment sheets, and job sheets to national standards, as those standards are made available.
4. **Related academic and workplace skills list**—Classifies unit tasks (assignment sheets and job sheets) according to related academic and workplace skills and competencies being reinforced. Skill areas reflected by skill groups, sub skills, and definitions have been matched with *What Work Requires of Schools: A SCANS Report for America 2000* and *Workplace Basics: The Skills Employers Want*.
5. **Tools, equipment, and materials list**—Provides a comprehensive list of those items needed to successfully complete the assignment/job sheets and assists administrators/teachers in determining program costs.
6. **Reference list**—Provides a comprehensive list of resources used in the development of this publication.

Use of This Publication

Instructional Units

Major Appliance Repair contains 14 units of instruction. Each instruction unit in a teacher edition includes some or all of the following basic components: objective sheet, suggested activities, answers to assignments sheets, answers to the written test, written test, and a unit evaluation form, teacher supplements, transparency masters, information sheet, student supplements, assignment sheets, and job sheets.

All of the unit components focus on observable and measurable learning outcomes. Teachers are encouraged to supplement, personalize, localize, and motivate with these materials in order to develop a complete teaching/learning process.

Units of instruction are designed for use in more than one lesson or class period of instruction. Careful study of each unit of instruction by the teacher will help to determine the following:

- ☐ Amount of materials that can be covered in each class period.
- ☐ Skills that must be demonstrated.
- ☐ Amount of class time needed for demonstrations.
- ☐ Amount of time needed for student practice.
- ☐ What must be obtained for supplementary materials such as other printed materials, video tapes, CD-ROMs, or other equipment and supplies.
- ☐ Resource people who must be contacted.

Objective Sheet

Each unit of instruction is based on performance objectives stated generally in the unit objective as performance activities. Specific objectives provide the student with the information needed to reach the unit objective and a successful completion of the course.

The objectives should be provided for students and stressed throughout the teaching/learning process. This will help answer questions concerning performance requirements, and also help determine teaching strategies and instructional methods.

As teachers plan instruction, they should feel free to modify, delete, or add objectives in order to meet the needs of the student and the community. When objectives are added or modified, the teacher should supply students with the information sheet materials or assignment or job sheets and criterion-referenced test items.

Suggested Activities

This component is included only in the teacher edition. The suggested activities assist teachers in the preparation stage by providing an instructional plan, teaching suggestions, and a list of supplemental resources. Ways to integrate academic and workplace skills have been included in the suggestions, and skill areas have been noted in boldface type. A table of academic and workplace skills is also provided on page xxxvii. Before teaching each unit, the teacher should read the suggested activities and decide how each objective can best be taught. Teachers should also allow time to obtain supplemental materials, prepare audiovisual or other teaching aids, and contact outside resources.

References used in the development of each unit are listed in suggested activities along with supplemental resources. These materials can be used to supplement teacher expertise and to help students with special interests in specific areas of instruction.

Instructions for evaluating student job sheet performance are also included in the suggested activities. Teachers should select and discuss with students the rating scale that will be used.

Answers to Assignment Sheet and Answers to Written Test

Answers to both the assignment sheets and written test are provided to save instructors time in properly evaluating student achievement.

Written Test

This component provides a criterion-referenced test question for every cognitive objective in the unit of instruction. The test appears in the teacher edition, but duplication is permitted for student use. If the objective sheet is modified, such changes should be noted on the written test. It is also recommended that the test be divided into shorter tests covering three or four objectives and given soon after the objectives have been taught. The test may also be used as a pretest to identify student skill level, and items from individual units can be combined for a final test at the end of a term or semester.

Unit Evaluation

This sheet provides teachers with a record of student performance at the end of each unit. It includes space for assignment sheet ratings, job sheets ratings, written test scores, both pretest and posttest, and an area for teacher comments. The unit evaluation is in the teacher edition only, but it may be duplicated as needed for placement in student records or portfolios.

Use of This Publication

Teacher Supplements

This component is in the teacher edition only and designed to be used for a variety of purposes: to provide the teacher with higher level materials to challenge advanced students, to provide remedial information or practice that may assist less-advanced students, and to provide the teacher with state-of-the-art information not readily available from other sources. Teacher supplements may be duplicated as needed for student use.

Transparency Masters

Transparency masters are in the teacher edition only. They need to be copied and used on overhead projectors to help enhance specific objectives in the text. Charts, schematics, pictorials, and schematics serve to visually reinforce specific objectives.

Information Sheet

The information sheet provides the content essential for meeting the cognitive objectives of the unit. It is an excellent guide for presenting the tools, materials, and processes necessary for a student to complete the unit performance skills. The information sheet has generous margins that can be used for notes to help both teachers and students clarify materials and localize and personalize objectives.

Student Supplements

Student supplements may be part of the student edition. They are frequent charts or tables that students may need to access while completing assignment or job sheets. The supplement may also present optional materials of interest or items such as troubleshooting charts that students may retain for reference in later study or the workplace.

Assignment Sheets

Assignment sheets are mostly pencil and paper activities that permit students to practice with math, work with reference materials, or generally make a practical application of items in the objective sheets. The assignment sheets help teachers objectively evaluate skills that are sometimes difficult to assess otherwise, and spot problem areas where a student may require review or special help.

Job Sheets

The job sheets are the activities that provide the student with hands-on applications to demonstrate their abilities to apply what they have learned from the information sheet. The sheets detail a list of tools and equipment the student will require and tell the student exactly how the psychomotor performance will be rated. Teachers should demonstrate job sheets and provide students with appropriate materials to work with and a safe classroom/lab environment in which to complete the activity. Job sheets are a critical part of each unit because they provide potential employers with a picture of skills being taught during training and the performance level that can be expected from a student.

*Major Appliance Repair
Second Edition*

Competency Profile

Name: _____

Directions: Evaluate the student using the rating scale below. Write the appropriate number to indicate the degree of competency achieved. The descriptions associated with each of the numbers focuses on a level of student performance for each of the tasks listed. The written test scoreline is provided for optional teacher use. It may not be applicable in all cases.

Option A

Rating scale:

- 4 - Skilled - Can perform job with no additional training
- 3 - Moderately Skilled - Has performed job during training program; limited additional training may be required.
- 2 - Limited Skill - Has performed job during training program; additional training is required to develop skill.
- 1 - Unskilled - is familiar with process, but is unable to perform job.
- 0 - No Exposure - No information or practice provided during training program, complete training required.
- NA - Non-applicable.

Option B

Yes - Can perform with no additional training
No - Is unable to perform satisfactorily

Unit 1: Major Appliance Repair Orientation

_____ 1. (Instructor option)
_____ Written Test Score

Unit 2: Safety and First Aid

_____ 1. Select proper first aid procedures.
_____ 2. Solve problems about hazardous materials.
_____ 3. Complete a student safety pledge.
_____ 4. _____
_____ Written Test Score

Unit 3: Fundamentals of Electricity

_____ 1. Solve problems for an unknown voltage.
_____ 2. Solve problems for an unknown amperage.
_____ 3. Solve problems for an unknown resistance.
_____ 4. Identify resistor values using a standard color code.
_____ 5. _____
_____ Written Test Score

Competency Profile

Unit 4: AC Induction Motors

- _____ 1. Troubleshoot an AC induction motor for thermal overload problems.
- _____ 2. Troubleshoot an AC induction motor to determine whether the start mechanism or the start windings are bad, and replace a centrifugal switch.
- _____ 3. _____
- _____ Written Test Score

Unit 5: Diagrams and Schematics

- _____ 1. Interpret a timer sequence chart and wiring diagram for an automatic dishwasher.
- _____ 2. _____
- _____ Written Test Score

Unit 6: Tools, Materials, and Test Instruments

- _____ 1. Identify selected tools.
- _____ 2. Test electrical receptacles for proper voltages.
- _____ 3. Use a clamp-on ammeter to test for high and low amperages on a fan motor and a light bulb.
- _____ 4. Make a continuity check of a magnetic control assembly from an automatic washer.
- _____ 5. Splice electrical conductors to acceptable service standards.
- _____ 6. Use a VOM for a quick capacitor check.
- _____ 7. _____
- _____ Written Test Score

Unit 7: Automatic Washers

- _____ 1. Install an automatic washer.
- _____ 2. Troubleshoot a Whirlpool/Kenmore automatic washer for typical malfunctions.
- _____ 3. Troubleshoot a GE/Hotpoint automatic washer for typical malfunctions.
- _____ 4. Troubleshoot a microprocessor control panel for typical malfunctions.
- _____ 5. _____
- _____ Written Test Score

Competency Profile

Unit 8:

Automatic Dryers

- _____ 1. Install an automatic dryer.
- _____ 2. Troubleshoot a Whirlpool/Kenmore automatic dryer for typical malfunctions.
- _____ 3. Troubleshoot a FE/Hotpoint automatic dryer for typical malfunctions.
- _____ 4. Troubleshoot a microprocessor control panel for typical malfunctions.
- _____ 5. _____
- _____ Written Test Score

Unit 9:

Automatic Dishwashers

- _____ 1. Install an automatic dishwasher under a counter.
- _____ 2. Troubleshoot malfunctions on an automatic dishwasher.
- _____ 3. Inspect the seal on an automatic dishwasher.
- _____ 4. _____
- _____ Written Test Score

Unit 10:

Garbage Disposers

- _____ 1. Install a garbage disposer.
- _____ 2. Free a jammed garbage disposer.
- _____ 3. _____
- _____ Written Test Score

Unit 11:

Trash Compactors

- _____ 1. Use schematics to determine operating conditions on a trash compactor.
- _____ 2. Install an undercounter trash compactor to specifications.
- _____ 3. Test the drive motor on a trash compactor to determine its operational condition.
- _____ 4. Troubleshoot common trash compactor problems.
- _____ 5. _____
- _____ Written Test Score

Unit 12:

Gas Ranges and Ovens

- _____ 1. Use a wiring schematic to determine voltage and resistance readings on a self-cleaning gas oven set for a bake operation.
- _____ 2. Use a wiring schematic to determine voltage and resistance readings on a self-cleaning gas oven set for a timed bake operation.

Competency Profile

Unit 12: Gas Ranges and Ovens (Continued)

- _____ 3. Use a wiring schematic to determine voltage and resistance readings on a self-cleaning gas oven set for a cleaning operation.
- _____ 4. Use a wiring schematic to determine voltage and resistance readings on a self-cleaning gas oven during lock and unlock.
- _____ 5. Install a gas range level and leak free with all burners properly adjusted.
- _____ 6. Use a temperature tester to check gas oven temperature for proper oven thermostat settings.
- _____ 7. Recalibrate a gas oven thermostat to correct settings.
- _____ 8. Remove, disassemble, clean, lubricate, and reassemble a standard gas burner valve.
- _____ 9. _____
- _____ Written Test Score

Unit 13: Electric Ranges and Ovens

- _____ 1. Remove a surface unit from an electric range and check for proper resistance.
- _____ 2. Check the self-cleaning function on an electric oven.
- _____ 3. Make continuity checks on step-type and infinite electric range switches.
- _____ 4. _____
- _____ Written Test Score

Unit 14: Microwave Ovens

- _____ 1. Test the interlock system on a microwave oven for safe operation.
- _____ 2. Check an RF leakage test meter and check a microwave oven for RF leakage.
- _____ 3. Clean and deodorize a microwave oven.
- _____ 4. Determine if selected utensils are microwave safe.
- _____ 5. Discharge a capacitor.
- _____ 6. Check stirrer blade rotation and remove and disassemble a stirrer system.
- _____ 7. Replace and adjust a microwave oven door assembly.
- _____ 8. Conduct power tests on a microwave oven to check for temperature rise under full power.
- _____ 9. Test and replace high voltage components when an oven produces little or no heat.
- _____ 10. Remove a blower motor and transformer and remove and install a magnetron.

Competency Profile

Unit 14: Microwave Ovens (Continued)

- _____ 11. Check the interlock switch module on a microwave oven.
- _____ 12. Test and replace magnetron and cavity thermal protectors.
- _____ 13. Test and replace a low voltage transformer and triac module.
- _____ 14. Test a temperature probe and jack.
- _____ 15. Test and replace an oven timer and an oven controller.
- _____ 16. Remove, test, and replace a control board.
- _____ 17. Test a control circuit board.
- _____ 18. Test a cook relay.
- _____ 19. Test and replace a turntable motor.
- _____ 20. _____
- _____ Written Test Score

Comments: _____

Evaluator: _____ Date: _____

Permission to duplicate this profile is granted.

Major Appliance Repair
Second Edition

Instructional/Task Analysis

Related Information:
What the Student Should Know

Application:
What the Student Should be Able to Do

Unit 1: Major Appliance Repair Orientation

1. Terms and definitions
2. The job outlook for appliance repair
3. Advancement opportunities for appliance repair technicians
4. Where appliance repair technicians work
5. Working conditions
6. Training requirements for appliance repair work
7. Physical requirements for successful appliance repair technicians
8. Personal habits that promote success on the job
9. Repair technicians and customer relations
10. Warranties and their importance
11. Cautions about warranties
12. Guidelines for service calls

Instructional/Task Analysis

Related Information:
What the Student Should Know

Application:
What the Student Should be Able to Do

Unit 2: Safety and First Aid

- | | |
|---|---|
| 1. Terms and definitions | 26. Select proper first aid procedures.
(Assignment Sheet 1) |
| 2. Benefits of safe working practices | |
| 3. Major Causes of accidents | 27. Solve problems about hazardous
materials. (Assignment Sheet 2) |
| 4. Guidelines for good housekeeping | 28. Complete a student safety pledge.
(Assignment Sheet 3) |
| 5. Basic rules for safe use of tools and
equipment | |
| 6. Steps in lifting safely | |
| 7. Special lifting rules for appliance
repair | |
| 8. MSDS information and its details | |
| 9. Problems and health effects of
hazardous chemicals | |
| 10. The diamond classification system
for hazardous chemicals | |
| 11. Fire safety rules | |
| 12. Classes of fires and their causes | |
| 13. Types of fire extinguishers and their
recommended uses | |
| 14. Types of fire extinguishers and their
recommended operations | |
| 15. Special safety requirements for
appliance repair | |
| 16. Special rules for eye protection | |
| 17. Ways to recognize shock | |
| 18. Steps in treating shock | |

Instructional/Task Analysis

Related Information: What the Student Should Know

19. First aid for victims of electrical shock
20. First aid guidelines for common workplace injuries
21. First aid guidelines for workplace burns
22. Steps in controlling bleeding
23. Pressure points for checking bleeding
24. First aid for eye injuries
25. General guidelines for first aid emergencies

Application: What the Student Should be Able to Do

Unit 3: Fundamentals of Electricity

- | | |
|--|---|
| 1. Terms and definitions | 24. Solve problems for an unknown voltage (Assignment Sheet 1) |
| 2. What electricity is | 25. Solve problems for an unknown amperage (Assignment Sheet 2) |
| 3. Sources of electricity | 26. Solve problems for an unknown resistance (Assignment Sheet 3) |
| 4. The electron theory | 27. Identify resistor values using a standard color code (Assignment Sheet 4) |
| 5. The importance of electrical charges | |
| 6. How electron flow is created in a conductor | |
| 7. Conductors, insulators, and semi-conductors | |
| 8. Direct current | |
| 9. Alternating current | |
| 10. Basic Electrical symbols | |
| 11. Types of circuits | |

Instructional/Task Analysis

Related Information:

What the Student Should Know

12. Elements of a basic circuit
13. Circuit applications
14. Circuit grounding
15. Electrical measurements
16. Abbreviations in Ohm's law
17. Ohm's law for electrical circuits
18. Using Ohm's law to find unknown values in a circuit
19. Characteristics of electrical power
20. Ways Ohm's law is used
21. Kirchhoff's laws for voltage and current
22. Working with resistors
23. Steps in using the color code to determine resistor value

Application:

What the Student Should be Able to Do

Unit 4: AC Induction Motors

- | | |
|--------------------------------------|---|
| 1. Terms and definitions | 24. Troubleshoot an AC induction motor for thermal overload problems (Job Sheet 1) |
| 2. Principles of magnetism | 25. Troubleshoot an AC induction motor to determine whether the start mechanism or the start windings are bad, and replace a centrifugal switch (Job Sheet 2) |
| 3. The left hand rule for conductors | 26. Bench test a single-speed motor with a test cord (Job Sheet 3) |
| 4. Electromagnets and coils | |
| 5. Other principles of magnetism | |
| 6. Types of transformers | |
| 7. DC motor components | |

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should be Able to Do

8. DC motor operation
9. AC induction motors
10. AC induction motor components and their functions
11. Types of AC induction motors
12. Operations of an induction start, induction run motor
13. Operations of a capacitor start, induction run motor
14. Motor housings
15. Motor speeds
16. Types of motor bearings and their characteristics
17. Motor thermal protection
18. Other motor problems
19. Using compressor test cords in motor testing
20. Guidelines for servicing throw-away motors
21. Motor nameplate information
22. Motor safety
23. Steps in systematically troubleshooting an induction motor

Instructional/Task Analysis

Related Information:
What the Student Should Know

Application:
What the Student Should be Able to Do

Unit 5: Diagrams and Schematics

- | | |
|--|--|
| 1. Terms and definitions | 13. Interpret a timer sequence chart and wiring diagram for an automatic dishwasher (Assignment Sheet 1) |
| 2. Block Diagrams | |
| 3. Schematic diagrams | |
| 4. Wiring diagrams | |
| 5. Other graphic aids and their functions | |
| 6. Where to find helpful graphic aids | |
| 7. Timer sequence charts | |
| 8. What legends do | |
| 9. Common color code abbreviations | |
| 10. Basic electrical symbols | |
| 11. Symbols for solid state devices | |
| 12. Guidelines for using diagrams and schematics | |

Unit 6: Tools, Materials, and Test Equipment

- | | |
|---|---|
| 1. Terms and definitions | 26. Identify selected tools (Assignment Sheet 1) |
| 2. Basic hand tools | |
| 3. Shop tools | 27. Test electrical receptacles for proper voltages (Job Sheet 1) |
| 4. Miscellaneous supplies | 28. Use a clamp-on ammeter to test for high and low amperages on a fan motor and a light bulb (Job Sheet 2) |
| 5. Appliance repair literature and its uses | |
| 6. VOM's and their uses | 29. Make a continuity check of a magnetic control assembly from an automatic washer (Job Sheet 3) |

Instructional/Task Analysis

Related Information:

What the Student Should Know

7. Clamp-on ammeters and their uses
8. Digital multimeters and their uses
9. Temperature testers and their uses
10. Capacitor analyzers and their uses
11. Wattmeters and their uses
12. Shunts and their functions in ammeters
13. Electrical measurements and ways to make them
14. Appliance wiring
15. Soldering tools
16. Resin-core solder and its characteristics
17. Procedure for using solid wire solder
18. Steps in wire stripping
19. Types of splices
20. Guidelines for connections at screw terminals
21. Guidelines for good soldered splices
22. Guidelines for using solderless connectors and terminals
23. Proper care and use of hand tools
24. Guidelines for using other tools and equipment
25. Eye protection

Application:

What the Student Should be Able to Do

30. Splice electrical conductors to acceptable service standards .(Job Sheet 4)
31. Use a VOM for a quick capacitor check (Job Sheet 5)

Instructional/Task Analysis

Related Information:
What the Student Should Know

Application:
What the Student Should be Able to Do

Unit 7: Automatic Washers

- | | |
|--|--|
| 1. Terms and definitions | 21. Install an automatic washer (Job Sheet 1) |
| 2. Major components and their functions in an automatic washer | 22. Troubleshoot a Whirlpool/Kenmore automatic washer for typical malfunctions (Job Sheet 2) |
| 3. Steps in a typical automatic washer cycle | 23. Troubleshoot a GE/Hotpoint automatic washer for typical malfunctions (Job Sheet 3) |
| 4. Fill functions in a normal cycle | 24. Troubleshoot a microprocessor control panel for typical malfunctions (Job Sheet 4) |
| 5. Agitation functions in a normal cycle | |
| 6. Pumpout and spin functions in a normal cycle | |
| 7. Guidelines for evaluating automatic washer malfunctions | |
| 8. Steps for validating repairs | |
| 9. Troubleshooting a washer that will not fill with water | |
| 10. Troubleshooting a washer for improper water level or water temperature | |
| 11. Troubleshooting a washer when water will not shut off | |
| 12. Troubleshooting a washer that leaks water | |
| 13. Troubleshooting when water will not drain from a washer | |
| 14. Troubleshooting a washer with a motor that will not run | |
| 15. Troubleshooting a washer that will not agitate | |
| 16. Troubleshooting a washer that will not spin | |

Instructional/Task Analysis

Related Information: What the Student Should Know

17. Troubleshooting a washer that will not advance or shut off
18. Troubleshooting a washer that leaks oil
19. Troubleshooting a washer that tears clothing
20. Other washer problems and ways to correct them

Application: What the Student Should be Able to Do

Unit 8: Automatic Dryers

- | | |
|---|---|
| 1. Terms and definitions | 13. Install an automatic dryer (Job Sheet 1) |
| 2. Major components and their functions in an automatic dryer | 14. Troubleshoot a Whirlpool/Kenmore automatic dryer for typical malfunctions (Job Sheet 2) |
| 3. Steps in automatic dryer operation | 15. Troubleshoot a GE/Hotpoint automatic dryer for typical malfunctions (Job Sheet 3) |
| 4. Thermostats and their functions in a dryer | 16. Troubleshoot a microprocessor control panel for typical malfunctions (Job Sheet 4) |
| 5. Troubleshooting a dryer that will not run | |
| 6. Troubleshooting a dryer that will run but not heat | |
| 7. Troubleshooting a dryer when the motor runs but the drum will not turn | |
| 8. Troubleshooting a dryer that runs but will not shut off | |
| 9. Troubleshooting a dryer that runs and heats but will not dry clothes | |
| 10. Other dryer problems and their solutions | |

Instructional/Task Analysis

Related Information: What the Student Should Know

11. Troubleshooting gas valves and igniters on gas dryers
12. Special dryer problems and their solutions

Application: What the Student Should be Able to Do

Unit 9: Automatic Dishwashers

- | | |
|---|--|
| 1. Terms and definitions | 12. Install an automatic dishwasher under a counter (Job Sheet 1) |
| 2. Major components of a dishwasher and their functions | 13. Troubleshoot malfunctions on an automatic dishwasher (Job Sheet 2) |
| 3. Steps in an automatic dishwasher cycle | 14. Inspect the seal on an automatic dishwasher (Job Sheet 3) |
| 4. Special considerations for dishwasher installation | |
| 5. Water problems with dishwashers | |
| 6. Loading order in dishwasher operation | |
| 7. Dishwasher misuses and their causes | |
| 8. Guidelines for better dishwasher service | |
| 9. Guidelines for troubleshooting automatic dishwashers | |
| 10. Ways to prevent mineral build-up in an automatic dishwasher | |
| 11. Troubleshooting redeposit problems | |

Instructional/Task Analysis

Related Information:
What the Student Should Know

Application:
What the Student Should be Able to Do

Unit 10: Garbage Disposers

- | | |
|---|--|
| 1. Terms and definitions | 12. Install a garbage disposer (Job Sheet 1) |
| 2. First consideration for garbage disposers | 13. Free a jammed garbage disposer (Job Sheet 2) |
| 3. Safety rules for disposer operation | |
| 4. Major components of a garbage disposer and their functions | |
| 5. Steps in garbage disposer operation | |
| 6. The importance of cold water flow in a disposer | |
| 7. Common misuses that cause disposer problems | |
| 8. Items that can be placed into a garbage disposer | |
| 9. Guidelines for handling a jammed garbage disposer | |
| 10. Guidelines for installing a garbage disposer | |
| 11. Guidelines for troubleshooting disposer malfunctions | |

Instructional/Task Analysis

Related Information:
What the Student Should Know

Application:
What the Student Should be Able to Do

Unit 11: Trash Compactors

- | | |
|--|---|
| 1. Terms and definitions | 16. Use schematics to determine operating conditions on a trash compactor (Assignment Sheet 1) |
| 2. Trash compactor characteristics | |
| 3. Steps in a typical compactor cycle | 17. Install an undercounter trash compactor to specifications (Job Sheet 1) |
| 4. Compactor electrical components and their characteristics | |
| 5. Trash compactor operating safety | 18. Test the drive motor on a trash compactor to determine its operations condition (Job Sheet 2) |
| 6. Trash compactor service safety | |
| 7. Guidelines for properly loading a compactor | 19. Troubleshoot common trash compactor problems (Job Sheet 3) |
| 8. Common causes for failure to compact | |
| 9. Major wear problems with compactors | |
| 10. Lubrication requirements for compactors | |
| 11. Chain and belt adjustments | |
| 12. Troubleshooting guidelines for trash compactor problems | |
| 13. Guidelines for troubleshooting a noisy compactor | |
| 14. Troubleshooting other compactor problems | |
| 15. Items that should not be placed in a trash compactor | |

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should be Able to Do

Unit 12: Gas Ranges and Ovens

- | | |
|---|---|
| 1. Terms and definitions | 31. Use a wiring schematic to determine voltage and resistance readings on a self-cleaning gas oven set for a bake operation (Assignment Sheet 1) |
| 2. Basics of gas heating | |
| 3. Natural and bottled gases | |
| 4. How a gas range top burner works | 32. Use a wiring schematic to determine voltage and resistance readings on a self-cleaning gas oven set for a times bake operation (Assignment Sheet 2) |
| 5. Orifice settings | |
| 6. Primary and secondary air | |
| 7. Byproducts of combustion | 33. Use a wiring schematic to determine voltage and resistance readings on a self-cleaning gas oven set for a cleaning operation (Assignment Sheet 3) |
| 8. Burner combustion problems | |
| 9. Gas burner types and their applications | 34. Use a wiring schematic to determine voltage and resistance readings on a self-cleaning gas oven during lock and unlock (Assignment Sheet 4) |
| 10. Ignition systems and their characteristics | |
| 11. How a gas oven works | 35. Install a gas range level and leak free with all burners properly adjusted (Job Sheet 1) |
| 12. Types of oven thermostats and their characteristics | |
| 18. Safety valves | 36. Use a temperature tester to check gas oven temperature for proper oven thermostat settings (Job Sheet 2) |
| 14. Common misuses of gas ovens | |
| 15. Considerations for ovens with upper and lower burners | 37. Recalibrate a gas oven thermostat to correct settings (Job Sheet 3) |
| 16. Special safety features of self-cleaning ovens | 38. Remove, disassemble, clean, lubricate, and reassemble a standard gas burner valve (Job Sheet 4) |
| 17. Special safety features of self-cleaning ovens | |
| 18. Safety requirements for gases | |

Instructional/Task Analysis

Related Information: What the Student Should Know

19. Flexible connectors
20. Requirements for gas supply lines
21. Functions of electrical circuits on gas ovens
22. Typical circuit functions in a gas oven
23. Range complaints and recommended troubleshooting
24. Gas pressure drops
25. Manometer selection and use
26. Guidelines for roasting
27. Guidelines for broiling
28. Guidelines for baking
29. Baking problems and their solutions
30. Guidelines for service calls

Application: What the Student Should be Able to Do

Unit 13: Electric Ranges and Ovens

- | | |
|---|--|
| 1. Terms and definitions | 11. Remove a surface unit from an electric range and check for proper resistance (Job Sheet 1) |
| 2. Basics of electric cooking | |
| 3. Electrical requirements for hooking up an electric range | 12. Check the self-cleaning function on an electric oven (Job Sheet 2) |
| 4. Electric surface and oven heating elements | 13. Make continuity checks on step-type and infinite electric range switches (Job Sheet 3) |
| 5. Types of heat controls for surface heating elements | |
| 6. Types of electric oven thermostats | |

Instructional/Task Analysis

Related Information: What the Student Should Know

7. Recalibrating electric oven thermostats
8. Typical electric oven self-cleaning operation
9. Components and their functions in a self-clean cycle
10. Troubleshooting electric ranges

Application: What the Student Should be Able to Do

Unit 14: Microwave Ovens

- | | |
|---|--|
| 1. Terms and definitions | 25. Test the interlock system on a microwave oven for safe operation (Job Sheet 1) |
| 2. Microwaves and microwave ovens | |
| 3. Microwave oven controlling standards | 26. Check an RF leakage test meter and check a microwave oven for RFV leakage (Job Sheet 2) |
| 4. The performance standard for microwave ovens | 27. Clean and deodorize a microwave oven (Job Sheet 3) |
| 5. FCC microwave standards | 28. Determine if selected utensils are microwave safe (Job Sheet 4) |
| 6. Basic microwave components and their functions | 29. Discharge a capacitor (Job Sheet 5) |
| 7. Magnetron structure and operation | 30. Check stirrer blade rotation and remove and disassemble a stirrer system (Job Sheet 6) |
| 8. The significance of microwave reflection | 31. Replace and adjust a microwave oven door assembly (Job Sheet 7) |
| 9. The significance of microwave transmission | 32. Conduct power tests on a microwave oven to check for temperature rise under full power (Job Sheet 8) |
| 10. The significance of microwave absorption | |
| 11. Steps in microwave cooking | |
| 12. Steps in installing a microwave oven | |

Instructional/Task Analysis

Related Information:

What the Student Should Know

13. General rules for preventive maintenance
14. Major microwave oven components and their functions
15. Requirements for RF leakage test instruments
16. Spacer cones
17. Operating controls and their functions
18. Motors in microwave ovens
19. Door seals and their importance
20. Technical materials required for microwave oven service
21. Steps in troubleshooting a microwave
22. Pre-service inspection requirements
23. Safety requirements for microwave oven service
24. Post-service safety requirements

Application:

What the Student Should be Able to Do

33. Test and replace high voltage components when an oven produces little or no heat (Job Sheet 9)
34. Remove a blower motor and transformer and remove and install a magnetron (Job Sheet 10)
35. Check the interlock switch module on a microwave oven (Job Sheet 11)
36. Test and replace magnetron and cavity thermal protectors (Job Sheet 12)
37. Test and replace a low voltage transformer and a triac module (Job Sheet 13)
38. Test a temperature probe and a probe jack (Job Sheet 14)
39. Test and replace an oven timer and an oven controller (Job Sheet 15)
40. Remove, test, and replace a control board (Job Sheet 16)
41. Test a control circuit board (Job Sheet 17)
42. Test a cook relay (Job Sheet 18)
43. Test and replace a turntable motor (Job Sheet 19)

**Academic and Workplace Skills
(Classifications and Definitions)**

Skill Groups	Sub Skills	Definitions
Basic Skills	Reading	Comprehending written information and analyzing, and applying what has been read to a specific task.
	Writing	Communicating a thought, idea or fact in written form in a clear, concise manner.
	Arithmetic/ mathematics	Performing basic computations, applying estimating and reasoning skills, and solving practical problems using a variety of mathematical techniques.
	Science	Applying knowledge learned through study or practice that is based on scientific principles, methods, and techniques.
	Listening	Receiving, interpreting, and responding to oral messages and other cues.
	Speaking	Communicating a thought, idea, or fact orally in a clear, concise manner.
Thinking Skills	Creative thinking	Using imagination to generate new ideas.
	Decision making	Specifying goals and constraints, generating alternatives, considering risks, and evaluating and choosing the best alternative.
	Problem solving	Recognizing and defining problems, devising and implementing plan of action, and tracking and evaluating results.
	Seeing things in the mind's eye	Mentally organizing and processing symbols, pictures, graphs, and other information.
	Knowing how to learn	Using efficient learning techniques to acquire and apply new knowledge and skills.
	Reasoning	Applying a rule or principle underlying the relationship between two or more objects when solving a problem.
Personal Management Skills	Responsibility	Exerting a high level of effort towards goal attainment, working hard to become excellent at doing tasks by setting high standards, paying attention to details, and displaying a high level of concentration.
	Self-esteem	Developing self-confidence and creating a positive self-image.
	Career awareness development and mobility	Assessing self accurately, setting personal goals, establishing and implementing a plan, and monitoring progress.
	Integrity/honesty	Choosing an ethical course of action when faced with making a decision that may break with personal or societal values and recognizing the impact of violating these beliefs and codes on an organization, self and others.
	Organizational effectiveness	Adapting to the organization's goals, values, culture, and traditional modes of operation.

Skill Groups	Sub Skills	Definitions
Resources	Time	Selecting relevant, goal-related activities, ranking them in order of importance, allocating time, and understanding, preparing, and following schedules.
	Money	Using or preparing budgets, making forecasts, keeping records, and making adjustments to meet objectives.
	Material and facilities	Acquiring, storing and using materials and space efficiently.
	Human resources	Assessing skills and distributing work accordingly, evaluating performance and providing feedback.
Interpersonal Skills	Teamwork	Working cooperatively with others to reach a common goal.
	Coaching	Helping others learn new skills.
	Leadership	Communicating ideas to justify position; accepting responsibility for others; and encouraging, persuading, convincing, or otherwise motivating an individual or group.
	Negotiation	Resolving conflict between two or more individuals through discussion and compromise.
	Customer service	Working and communicating with customers to satisfy their expectations.
	Cultural diversity	Working well with men and women and with a variety of ethnic, social, or educational backgrounds.
Information	Acquisition and evaluation	Identifying need for data, obtaining it from existing sources or creating it, and evaluating its relevance and accuracy.
	Organization and storage	Organizing, processing, and maintaining written or computerized records and other forms of information in a systematic way.
	Interpretation	Selecting and analyzing information and communicating the results to others.
	Processing	Using computers to acquire, organize, analyze, and communicate information.
Systems	Interrelationships	Knowing how social, organizational, and technological systems work and operate effectively.
	Monitoring	Distinguishing trends, predicting impact of actions of system operations, diagnosing deviations in systems' performance, and correcting malfunctions.
	Modification and design	Making suggestions to modify existing systems to improve products or services, and developing new or alternative systems.
Technology	Selection	Choosing procedures, tools, or equipment including computers and related technologies.
	Application	Demonstrating proper procedures for setting up and operating equipment.
	Maintenance and troubleshooting	Preventing, identifying, or solving problems with equipment, including computers and other technologies.

**SCANS Foundation Skills for
Major Appliance Repair, Second Edition**

<i>Task</i>	<i>Skill Group or Competency</i>	<i>Sub Skill or Competency</i>	<i>Description</i>
Unit 1: Major Appliance Repair Orientation (Unit presents cognitive skills only)			
Unit 2: Safety and First Aid			
Select proper first aid procedures (AS1)	Thinking Skills	Problem Solving	Recognizes problems and selects a solution
Solve problems about hazardous materials (AS2)	Thinking Skills	Problem Solving	Recognizes problems and provides solutions
Complete a student safety pledge (AS3)	Basic Skills	Reading	Interprets a written document and provides personal input
Unit 3: Fundamentals of Electricity			
Solve problems for an unknown voltage (AS1)	Technology competency	Application	Applies Ohm's law to determine an unknown voltage
Solve problems for an unknown amperage (AS2)	Technology competency	Application	Applies Ohm's law to determine an unknown amperage
Solve problems for an unknown resistance (AS3)	Technology competency	Application	Applies Ohm's law to determine an unknown resistance
Identify resistor values using a standard color chart (AS4)	Basic skills	Science	Compares resistor colors with a standard color chart to determine values
Unit 4: AC Induction Motors			
Troubleshoot an AC induction motor for thermal overload problems (JS1)	Technology competency	Application	Demonstrates the ability to find thermal overload problems in an AC induction motor
Troubleshoot an AC induction motor to determine whether the start mechanism or the start windings are bad, and replace a centrifugal switch	Technology competency	Application	Demonstrates the ability to find problem components in an AC induction motor and replace a switch

**SCANS Foundation Skills for
Major Appliance Repair, Second Edition**

Task	Skill Group or Competency	Sub Skill or Competency	Description
Unit 4: AC Induction Motors (Continued)			
Bench test a single-speed motor with a test cord (JS3)	Technology competency	Application	Demonstrates the ability to use a test cord to check a motor
Unit 5: Diagrams and Schematics			
Interpret a timer sequence chart and a wiring diagram for an automatic dishwasher (AS1)	Basic skills	Science	Interprets a timing chart and a wiring diagram for a major appliance
Unit 6: Tools, Materials, and Test Equipment			
Identify selected tools (AS1)	Thinking skills	Problem solving	Identifies tools by name
Test electrical receptacles for proper voltages (JS1)	Technology competency	Application	Demonstrates the ability to test source voltage in household electrical receptacles
Use a clamp-on ammeter to test for high and low amperages on a fan motor and a light bulb (JS2)	Technology competency	Application	Demonstrates the ability to use a specialized electrical test instrument
Make a continuity check of a magnetic control assembly from an automatic washer (JS3)	Technology competency	Application	Demonstrates the ability to complete a standard continuity check on an electrical device
Splice electrical conductors to acceptable service standards (JS4)	Technology competency	Application	Demonstrates the ability to splice and tape electrical wires for service
Use a VOM for a quick capacitor check (JS5)	Technology competency	Application	Demonstrates the ability to make a standard capacitor check

**SCANS Foundation Skills for
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<i>Task</i>	<i>Skill Group or Competency</i>	<i>Sub Skill or Competency</i>	<i>Description</i>
Unit 7: Automatic Washers			
Install an automatic washer (JS1)	Technology competency	Application	Demonstrates the ability to install a major appliance
Troubleshoot a Whirlpool/Kenmore automatic washer for typical malfunctions (JS2)	Technology competency	Application	Demonstrates the ability to troubleshoot an automatic washer for typical customer complaints
Troubleshoot a GE/Hotpoint automatic washer for typical malfunctions (JS3)	Technology competency	Application	Demonstrates the ability to troubleshoot an automatic washer for typical customer complaints
Troubleshoot a micro-processor control panel for typical malfunctions (JS4)	Technology competency	Application	Demonstrates the ability to troubleshoot an electronic control panel
Unit 8: Automatic Dryers			
Install an automatic dryer (JS1)	Technology competency	Application	Demonstrates the ability to install a major appliance
Troubleshoot a Whirlpool/Kenmore automatic washer for typical malfunctions (JS2)	Technology competency	Application	Demonstrates the ability to troubleshoot an automatic dryer for typical customer complaints
Troubleshoot a GE/Hotpoint automatic washer for typical malfunctions (JS3)	Technology competency	Application	Demonstrates the ability to troubleshoot an automatic dryer for typical customer complaints
Troubleshoot a micro-processor control panel for typical malfunctions (JS4)	Technology competency	Application	Demonstrates the ability to troubleshoot an electronic control panel

**SCANS Foundation Skills for
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Task	Skill Group or Competency	Sub Skill or Competency	Description
Unit 9: Automatic Dishwashers			
Install an automatic dishwasher under a counter (JS1)	Technology competency	Application	Demonstrates the ability to install a major appliance properly
Troubleshoot malfunctions on an automatic dishwasher (JS2)	Technology competency	Application	Demonstrates the ability to isolate problems on an automatic dish-washer
Inspect the seal on an automatic dishwasher (JS3)	Technology competency	Application	Demonstrates the ability to evaluate waterproof qualities of a seal
Unit 10: Garbage Disposers			
Install a garbage disposer (JS1)	Technology competency	Application	Demonstrates the ability to install a major appliance
Free a jammed garbage disposer (JS2)	Technology competency	Application	Demonstrates the ability to correct a malfunction in a disposer
Unit 11: Trash Compactors			
Use schematics to determine operating conditions on a trash compactor (AS1)	Basic skills	Science	Interprets a schematic to determine performance characteristics of a trash compactor
Install an undercounter trash compactor to specifications (JS1)	Technology competency	Application	Demonstrates the ability to properly install a major appliance
Test the drive motor on a trash compactor to determine its operational condition (JS2)	Technology competency	Application	Demonstrates the ability to conduct an electrical test on a motor
Troubleshoot common trash compactor problems (JS3)	Technology competency	Application	Demonstrates the ability to troubleshoot common trash compactor problems

**SCANS Foundation Skills for
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<i>Task</i>	<i>Skill Group or Competency</i>	<i>Sub Skill or Competency</i>	<i>Description</i>
Unit 12: Gas Ranges and Ovens			
Use a wiring schematic to determine voltage and resistance readings on a self-cleaning oven set for a bake operation (AS1)	Basic skills	Science	Determines electrical readings by interpreting a wiring schematic
Use a wiring schematic to determine voltage and resistance readings on a self-cleaning oven set for a timed bake operation (AS2)	Basic skills	Science	Determines electrical readings by interpreting a wiring schematic
Use a wiring schematic to determine voltage and resistance readings on a self-cleaning oven during lock and unlock (AS3)	Basic skills	Science	Determines electrical readings by interpreting a wiring schematic
Install a gas range level and leak free with all burners adjusted (JS1)	Technology competency	Application	Demonstrates the ability to install a gas range to safety standards and adjust burners
Use a temperature tester to check gas oven temperature for proper oven thermostat settings (JS2)	Technology competency	Application	Demonstrates the ability to use a tester to check oven thermostat settings
Recalibrate a gas oven thermostat to correct settings (JS3)	Technology competency	Application	Demonstrates the ability to check and recalibrate a gas oven thermostat
Remove, disassemble, clean, lubricate, and reassemble a standard gas burner valve (JS4)	Technology competency	Application	Demonstrates the ability to disassemble, inspect, and reassemble a gas burner valve

**SCANS Foundation Skills for
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Task	Skill Group or Competency	Sub Skill or Competency	Description
Unit 13: Electric Ranges and Ovens			
Remove a surface unit from an electric range and check for proper resistance (JS1)	Technology competency	Application	Demonstrates the ability to safely check resistance on an electric range surface unit
Check the self-cleaning function on an electric oven (JS2)	Technology competency	Application	Demonstrates the ability to safely monitor and check a self-cleaning function on an electric range
Make continuity checks on step-type and infinite electric range switches (JS3)	Technology competency	Application	Demonstrates the ability to safely check operational characteristics of electric range switches
Unit 14: Microwave Ovens			
Test the interlock system on a microwave oven for safe operation (JS1)	Technology competency	Application	Demonstrates the ability to check for safe operation of an interlock system on a microwave oven
Check an RF leakage test meter and check a microwave oven for RF leakage (JS2)	Technology competency	Application	Demonstrates the ability to evaluate a test meter and use it to check for RF leakage
Clean and deodorize a microwave oven (JS3)	Technology competency	Application	Demonstrates the ability to clean a microwave oven
Determine if selected utensils are microwave safe (JS4)	Technology competency	Application	Demonstrates the ability to check utensils for safe use in a microwave
Discharge a capacitor (JS5)	Technology competency	Application	Demonstrates the ability to safely discharge a capacitor
Check stirrer blade rotation and remove and disassemble a stirrer system (JS6)	Technology competency	Application	Demonstrates the ability to check and disassemble a stirrer system for evaluation

**SCANS Foundation Skills for
Major Appliance Repair, Second Edition**

Task	Skill Group or Competency	Sub Skill or Competency	Description
Unit 14: Microwave Ovens (Continued)			
Replace and adjust a microwave oven door assembly (JS7)	Technology competency	Application	Demonstrates the ability to service a microwave oven door
Conduct power tests on a microwave oven to check for temperature rise under full power (JS8)	Technology competency	Application	Demonstrates the ability to conduct a temperature rise test with a microwave under full power
Test and replace high voltage components when an oven produces little or no heat (JS9)	Technology competency	Application	Demonstrates the ability to test and replace high voltage components on a malfunctioning microwave
Remove a blower motor and transformer and install a magnetron (JS10)	Technology competency	Application	Demonstrates the ability to prepare a microwave for safe installation of a magnetron
Check the interlock switch on a microwave oven (JS11)	Technology competency	Application	Demonstrates the ability to check an important interlock safety function
Test and replace a magnetron and cavity thermal protectors (JS12)	Technology competency	Application	Demonstrates the ability to replace protection devices in a microwave
Test and replace a low voltage transformer and a triac module (JS13)	Technology competency	Application	Demonstrates the ability to test and replace electrical components on a microwave
Test a temperature probe and a probe jack (JS14)	Technology competency	Application	Demonstrates the ability to test a temperature probe and a probe jack
Test and replace an oven timer and oven controller (JS15)	Technology competency	Application	Demonstrates the ability to test and replace oven control devices
Remove, test, and replace a control board (JS16)	Technology competency	Application	Demonstrates the ability to test and replace a control board
Test a control circuit board (JS17)	Technology competency	Application	Demonstrates the ability to test a control circuit board

**SCANS Foundation Skills for
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Task	Skill Group or Competency	Sub Skill or Competency	Description
Unit 14: Microwave Ovens (Continued)			
Test a cook relay (JS18)	Technology competency	Application	Demonstrate the ability to test and evaluate a cook relay
Test and replace a turntable motor (JS19)	Technology competency	Application	Demonstrates the ability to test a motor and replace as needed

Major Appliance Repair, Second Edition

Tools, Equipment, and Materials List

Hand tools

Tool chest and lock
Standard screwdriver set
Phillips screwdriver set
Offset standard and Phillips screwdrivers
Stubby standard and Phillips screwdrivers
Allen wrench set
Nutdriver set
Combination wrench set
Adjustable wrenches
Standard and Phillips screw starters
Slip-joint pliers
Locking jaw (vise-grip) pliers
Needlenose pliers
Diagonal (sidecutting pliers)
Lineman's pliers
Hose-clamp pliers
Internal and external snap-ring pliers
Electrical terminal pliers
Ball peen hammer
Soft-faced hammer
Chisel set
Punch Set
Drive socket set
Ratchet socket set
Pipe wrenches
Tape measure

Test Equipment

Volt-Ohmmeter (multimeter)
Digital VOM
Clamp-on ammeter
Wattmeter
Capacitor analyzer
Temperature tester

Shop tools

Appliance dolly
Appliance flipper
Compressed air supply
Wet/dry shop vacuum
File set
Keyhole saw
Hacksaw and extra blades
Pry bar
Heavy duty drill
Drill bit set (steel)
Drill bit set (wood)
Masonry drill
Soldering gun and solder
Test cord
Aviation snips
Level
Drill press
Bench grinder
Oxyacetylene cutting equipment

Miscellaneous tools and supplies

Drop cloth
Inspection light
Electrical tape
Pipe dope
Clean shop towels

Safety and First Aid Equipment

Fire extinguishers
First aid kit
Eye wash station

**Tools, Equipment, and Materials List
for Microwave Ovens**

Sixteen-ounce beaker
Nine-volt battery
RF leakage detection meter
Fresh lemon
Cleaning cloth
Pan
Tablespoon
Standard hand tools
Screwdriver with insulated handle
Needle nose pliers with insulated handles
20K Ω resistor
Crows-foot type wrench (Litton)
Centigrade thermometer
Stop watch or watch with a second hand
Ohmmeter with Rx10,000 range or greater
VOM
Jumper wire
Utility knife (X-Acto type)
Electrical tape
Pencil and paper
Safety glasses

Major Appliance Repair, Second Edition

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Repair-Master for Electric Ranges and Controls. Santa Monica, CA 90404: Master Publications, Inc., 1980.

Repair-Master for General Electric Automatic Washers. Garden Grove, CA 92642: Master Publications, a Gem Products, Inc. Company, 1985

Repair-Master for General Electric Gas & Electric Dryers. Santa Monica, CA 90404: Master Publications, Inc., 1980.

Repair-Master for Gas Ranges and Controls. Santa Monica, CA 90404: Master Publications, Inc., 1980.

Repair-Master for Hamilton Gas & Electric Dryers. Santa Monica, CA 90404: Master Publications, Inc., 1980.

Repair-Master for Norge Gas & Electric Dryers, Santa Monica, CA 90404: Master Publications Inc., 1980.

Repair-Master for Speed Queen Automatic Washers. Santa Monica, CA: 90404: Master Publications, Inc., 1980.

Service Information Manual, The 1500 Series, Model 1510.000. Minneapolis, MN 55440: Litton Systems, Inc., 1979.

Step-by-Step Repair Manual Plus Preventive Maintenance for General Electric/Hotpoint Dishwashers. Louisville, KY 40225: General Electric Co., 1985.

Step-by-Step Repair Manual Plus Preventive Maintenance for General Electric/Hotpoint Dryers. Louisville, KY 40225: General Electric Co., 1985.

Step-by-Step Manual Plus Preventive Maintenance for General Electric/Hotpoint Ranges. Louisville, KY 40225: General Electric Co., 1985.

Step-by-Step Repair Manual Plus Preventive Maintenance for General Electric/Hotpoint Washers. Louisville, KY 40225: General Electric Co., 1985.

Teague, Cash and Garner Pewewardy. *Industrial Electricity Motors*. Stillwater, OK 74074: Curriculum and Instructional Materials Center, Oklahoma State Department of Vocational and Technical Education, 1984.

**References Used in Developing This Text
(Continued)**

Tech-Talk "M" Clothes Washers. Dayton, OH 45449: Frigidaire Parts and Service Company, 1983.

Tech-Talk "M" Dryers. Dayton, OH 45449: Frigidaire Parts and Service Company, 1983.

Tech-Talk "J" Dishwashers. Dayton, OH 45449: Frigidaire Parts and Service Company, 1981.

**Major Appliance Repair Orientation
Unit 1**

Unit Contents

Teacher Components

	Teacher Page
1. Suggested Activities	
a. Instructional Plan.....	1
b. Teaching Suggestions.....	2
c. Resources Used in Developing This Unit.....	2
d. Suggested Supplemental Resources.....	2
e. Instructions for Evaluating Student Performance.....	3
2. Written Test.....	5
3. Answers to Written Test.....	11
4. Unit Evaluation Form.....	13

Student Components

1. Objective Sheet.....	MAR-1
2. Information Sheet.....	MAR-3
3. Student Supplements	
Student Supplement 1--Warranty.....	MAR-11
Student Supplement 2--Warranty Service Invoice.....	MAR-13

Major Appliance Repair Orientation Unit 1

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction.
2. Review Teaching Suggestions. Plan for classroom activities.
3. Plan for students with special needs.
4. Obtain films, videotapes, and other resources to supplement instruction of this unit. See Resources and Suggested Supplemental Resources for more information.
5. Develop teaching plan. Adjust for different learning styles.
6. Review Instructions for Evaluating Student Performance.
7. Make copies of the Unit Evaluation Form, one for each student.

Delivery and Application

8. Provide students with unit of instruction.
9. Discuss unit and specific objectives.
10. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.

Evaluation

11. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.
12. Make copies of the written test. Add or modify test items as needed.
13. Give written test.
14. Compile written test scores on the Unit Evaluation Forms. Include any additional assignments or supplemental activities that should be part of the unit evaluation.
15. Reteach and retest as required.

Suggested Activities

Teaching Suggestions

Note: Skills areas appearing in **boldface** type in the following suggestions refer to foundation skills and competencies from *What Work Requires of Schools: a SCANS Report for America 2000*. These skills areas also address academic and workplace skills from a previous study by ASTD, the American Society for Training and Development.

1. Invite a local or area appliance store owner to talk to the students about appliance repair in general and what sort of job opportunities there are for entry-level technicians; have the owner also discuss the importance of recordkeeping and customer relations. **Basic skills, listening.**
2. Discuss the importance of proper attitudes about the workplace, and the personal habits that promote success in a job. **Personal management skills, self-esteem.**
3. Arrange with a local appliance repair firm for individual students to spend part of a day on a service truck. Try to arrange for the student(s) to accompany a working appliance repair technician in a service truck on a service call. Have individual students make brief oral reports to the class. **Basic skills, speaking.**

Resources Used in Developing This Unit

1. *Occupational Outlook Handbook*. Washington, DC 20402: U.S. Department of Labor, Bureau of Labor Statistics, 1996-97.
2. *Guide for Occupational Exploration*. Washington, DC 20402: U.S. Department of Labor, 1979.
3. Maze, Marilyn. *The Enhanced Guide For Occupational Exploration: Descriptions for the 2800 Most Important Jobs*. Indianapolis: JIST Works, Inc., 1995.

Suggested Supplemental Resources

1. CALLTAKER, a 19-minute video cassette showing how to take service calls over a phone. LIT677484 is the cassette number, and the accompanying test booklet is LIT677485.
2. CUSTOMER RELATIONS FOR APPLIANCE TECHNICIANS, a 23 minute video cassette presenting customer/technician situations including how to handle difficult customers and how to collect the bill. LIT787045 is the cassette number and the accompanying student study guide is LIT787046.
3. QUALITY--PASS IT ON, a 20-minute video cassette showing effective customer relations techniques. LIT787195 is the cassette number, the accompanying meeting leader's guide is LIT787196, and the accompanying discussion guide for students is LIT787197.

Suggested Activities

4. Video cassettes are available in ½" VHS or Beta formats and should be ordered from:
Whirlpool Corporation
ATTN: General Accounting
1900 Whirlpool Drive
La Porte , IN 46350-0927
- 5 For information about Whirlpool training materials, call:

(219) 325-2359
or
(219) 325-2230

Instructions for Evaluation Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

- 4 Skilled—Can perform job with no additional training.
- 3 Moderately skilled—Has performed job during training program; limited additional training may be required.
- 2 Limited skill—Has performed job during training program; additional training is required to develop skill.
- 1 Unskilled—Is familiar with process, but is unable to perform job.

Option B

- Yes—Can perform job with no additional training.
- No—Is unable to perform job satisfactorily.

**Major Appliance Repair Orientation
Unit 1**

Written Test

Name _____ Date _____ Score _____

1. Match each term on the right with its correct definition.

- | | | | |
|----------|--|----|-------------------|
| _____ a. | Labor saving devices such as can openers or toasters that are generally portable and relatively inexpensive | 1. | Electromechanical |
| _____ b. | Labor saving devices such as automatic washers and dryers that are generally stationary and relatively expensive | 2. | Major appliances |
| _____ c. | A mechanical part such as a solenoid that is started or stopped by an electrical control device | 3. | Habit |
| _____ d. | An act repeated so often that it becomes an automatic and unconscious personal trait | 4. | Small appliances |

2. Complete statements about the job outlook for appliance repair technicians. Circle the word(s) that best completes each statement.

- a. Well-trained appliance repair technicians should have **(excellent)** (good) (fair) (poor) employment prospects through the year 2005, especially if their background in electronics is strong.
- b. Current technicians who advance to other jobs or retire will **(have to be replaced)** (be replaced with automated processes).
- c. The number of appliances in homes will grow rapidly, but the use of electronic parts will **(raise)** (lower) the frequency with which they need to be serviced.
- d. Most homeowners consider major appliances essential, and available work should continue **(even during periods of economic recession)** (except for periods of economic recession).
- e. Pay varies with geographical area, but experienced technicians in 1995-96 earned from \$15 to \$20 per hour or more, and wages should **(increase)** (hold steady) with each passing year.

Written Test

3. Select true statements about advancement opportunities for appliance repair technicians place an "X" beside each true statement.

Note: For a statement to be true, all parts of the statement must be true.

- ____ a. After two to three years experience and a good work record, repair technicians may be promoted to:
- (1) Supervisor.
 - (2) Assistant service manager.
 - (3) Service manager.
 - (4) President of the company.
- ____ b. Highly skilled technicians with good people skills may advance to regional service manager or regional parts manager for a major manufacturer.
- ____ c. A technician with a wide range of skills, experience, and sufficient financial support may open his/her own appliance store or repair shop.

4. Complete a list of places where appliance repair technicians work. Insert the word(s) that best completes each statement.

- a. Most appliance repair technicians work in _____ appliance stores and repair shops.
- b. Many more appliance repair technicians work for manufacturers' service centers, department stores, wholesalers, or _____ companies.
- c. Some appliance repair technicians run their own businesses full or part time, and _____ their services to service centers or appliance dealers.
- d. Appliance repair technicians work in communities of all sizes, but most of them work in _____ areas.

5. Select true statements about working conditions by placing an "X" in the appropriate blanks.

- ____ a. Appliance repair shops are generally noisy, poorly lighted, and not comfortable places in which to work.
- ____ b. Most technicians work with strict supervision.
- ____ c. The work is generally safe as long as safety procedures are observed around electrical elements of equipment and as long as lifting and moving of heavy appliances is accomplished properly.

Written Test

- _____d. Technicians who repair appliances in customers' homes may sometimes have to drive a portion of the day and be responsible for the care of a company vehicle.
- _____e. Technicians who repair appliances in customers' homes also have to explain to the customer what repair work was done, the cost of parts and labor, and then collect the bill.
6. Complete statements about training requirements for appliance repair work. Insert the word(s) that best completes each statement.
- a. Although some repair technicians are trained _____, formal training in appliance repair is the more common route into the industry.
- b. Training should stress both the mechanical and electrical aspects of the repair industry and the _____.
- c. Modern appliances use more and more electronic parts, and technicians with good _____ skills have the best job prospects.
- d. Entry-level technicians frequently start out repairing _____ of appliance until they master it and then learn other appliances one at a time.
- e. Large department stores and service centers have _____ of their own to help technicians master advanced areas of repair.
- f. Technicians who make service calls in customer homes generally go through a period of on-the-job training with a _____ technician.
- g. Changes in appliance design demand that a technician keep up to date, and this usually means attending manufacturers' _____ where new models and service procedures are demonstrated.
- h. _____ manuals provide a wealth of information, and a good repair technician should read all manuals available and maintain a personal library of _____ manuals.
7. Complete a list of physical requirements for successful repair technicians. Circle the word(s) that best completes each statement.
- a. The occupation requires some **(moderate)** **(heavy)** lifting which requires a person to be in generally good physical condition
- b. The ability to identify **(wires)** **(schematics)** of several different colors is essential for some electrical elements of the occupation, and good eyesight is required.

Written Test

- c. Areas of the occupation require articulate skills in **(splicing) (soldering and tinning)**, and the technician needs to have a steady hand.
 - d. Much of the work is repetitive and requires an ability to tolerate **(doing the same thing over and over) (absolute boredom)**.
 - e. Technicians selected to service appliances in customer's home must have the **(verbal skills) (glib style)** required to talk with customers.
8. Select true statements about personal habits that promote success on the job. Place an "X" beside each true statement.
- ____ a. Take a bath or shower weekly.
 - ____ b. Get to work on time, and if you know you're going to be late or if you're too ill to go to work, try to call in far enough in advance so arrangements can be made for others to cover your job.
 - ____ c. Respect all company property and use tools and equipment any way so long as you get the job done.
 - ____ d. Think of yourself as an advertisement for the company anytime you're on a service call or using a company vehicle in public, and conduct yourself properly.
 - ____ e. Avoid drugs or alcohol because their use can impair your ability to work safely or to work at all.
 - ____ f. Be honest in all your relations with supervisors, fellow-workers, and customers.
 - ____ g. Put in a day's work for your day's pay.
9. Complete statements about repair technicians and customer relations. Circle the word(s) that best completes each statement.
- a. Appliance repair technicians mostly work for dealers who sell and service appliances and whose business **(depends) (only partly depends)** on good customer relations.
 - b. Repair technicians need basic **(math) (business)** skills in reading and interpreting work/service orders so they can approach customers with confidence.
 - c. Repair technicians need basic **(math) (business)** skills to total bills properly and avoid errors that could lose the company money or irritate a customer.
 - d. Repair technicians must be **(quiet) (diplomatic)** on service calls that take them into a customer's home.

Written Test

- e. Repair technicians should assume they **(are) (may be)** part of the company image at all times and conduct themselves accordingly.
10. Complete statements concerning warranties and their importance. Insert the word(s) that best completes each statement.
- a. Warranty:
- (1) usually runs for _____ full year.
 - (2) covers all defective workmanship and _____.
 - (3) pays for both parts and _____.
- b. Limited warranty:
- (1) usually runs from the second through the _____ year.
 - (2) usually covers only _____ components such as the transmission on an automatic washer.
 - (3) pays for parts, but customer pays for labor which includes _____ costs.
- c. Warranties should not be confused with dealer _____ that provide special services beyond what the manufacturer warranties.
11. Complete statements about cautions with warranties. Insert the word(s) that best completes each statement.
- a. Warranties are void if an appliance has been:
- (1) improperly _____ or modified.
 - (2) subjected to improper _____ supply.
 - (3) subjected to unreasonable _____.
- b. Service or repair work performed by an _____ technician voids most warranties.
- c. Payment for warranty work is made by manufacturers to authorized dealers and requires careful attention to _____.

Written Test

12. Solve problems concerning service calls. Provide the correct answer for each of the following situations.

a. A service order is not clear. What are two things that can be done to clarify it?

(1) _____

(2) _____

b. What are the first things you would do after a customer opens the door?

c. What would you do if the customer asked you to make a quick estimate of what the repairs will cost?

d. What would you do if the customer says a check will be mailed later to cover the bill?

e. What are two things you can do to leave the customer on a positive note?

(1) _____

(2) _____

Permission to duplicate this test is granted.

**Major Appliance Repair Orientation
Unit 1**

Answers to Written Test

1. a. 4
 b. 2
 c. 1
 d. 3
2. a. good
 b. have to be replaced
 c. lower
 d. even during periods of economic recession
 e. increase
3. b, c
4. a. independent
 b. utility
 c. contract
 d. highly populated metropolitan
5. c, d, e
6. a. on the job
 b. electromechanical
 c. electronics
 d. one type
 e. training programs
 f. more experienced
 g. seminars
 h. Service, service
7. a. heavy
 b. wires
 c. soldering and tinning
 d. doing the same thing over and over
 e. verbal skills
8. b, d, e, f, g
9. a. depends
 b. business
 c. math
 d. diplomatic
 e. are

Answers to Written Test

10. a. (1) one
(2) materials
(3) labor
b. (1) fifth
(2) specific
(3) travel
c. Service contracts
11. a. (1) installed
(2) voltage
(3) use
b. unauthorized
c. paperwork
12. a. (1) Talk to the person who took the order.
(2) Call the customer.
b. Introduce yourself, explain whom you represent, and why you are there.
c. Refuse politely.
d. Explain that you have to collect at the time service is completed.
e. (1) Assure the customer the appliance is working well.
(2) Compliment the customer on a wise appliance selection.

**Major Appliance Repair
Unit 1**

Unit Evaluation Form

Student Name _____ Date _____ Unit Rating _____

Written Test Scores

Pretest _____ Posttest _____ Other _____

Other _____

Teacher Signature _____ Date _____

Student Signature _____ Date _____

Permission to duplicate this form is granted.

60

**Safety and First Aid
Unit 2**

Unit Contents

Teacher Components

	Teacher Page
1. Suggested Activities	
a. Instructional Plan.....	1
b. Teaching Suggestions.....	2
c. Resources Used in Developing This Unit	2
d. Suggested Supplemental Resources	3
e. Instructions for Evaluating Student Performance	6
2. Answers to Assignment Sheets	7
3. Written Test	9
4. Answers to Written Test.....	23
5. Unit Evaluation Form	27

Student Components

1. Objective Sheet	MAR-15
2. Information Sheet	MAR-17
3. Student Supplements	
Student Supplement 1—MSDS Information	MAR-33
Student Supplement 2—Fire Safety.....	MAR-35
Student Supplement 3—Electrical Emergency Rescue Procedure	MAR-37
Student Supplement 4—Pressure Points for Checking Bleeding	MAR-39
Student Supplement 5—Accident Report Form	MAR-41
3. Assignment Sheets	
AS 1—Select Proper First Aid Procedures.....	MAR-43
AS 2—Solve Problems About Hazardous Materials	MAR-45
AS 3—Sign a Student Safety Pledge.....	MAR-47

Safety and First Aid Unit 2

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction or individual learning activities. Study the specific objectives to determine the order in which you will present the objectives.
2. Review Teaching Suggestions section that follows. Plan for classroom activities.
3. Plan enrichment of exceptional students as well as accommodation of special needs students.
4. Add overheads or other graphic materials as desired to enhance instruction.
5. Develop teaching plan. Adjust for different learning styles.
6. Make copy of the Unit Evaluation Form for each student.

Delivery and Application

7. Provide students with unit of instruction.
8. Discuss unit and specific objectives.
9. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic skills when applicable.
10. Discuss and demonstrate, as necessary, activities in the assignment sheets. Review criteria for evaluating these activities.

Evaluation

11. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.
12. Make copies of written test. Add or modify test items as needed.
13. Give written test.
14. Compile assignment sheet ratings and written test scores on the Unit Evaluation Form. Include any additional assignment or job sheets added to the unit.
15. Reteach and retest as required.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in **boldface** type in the Teaching Suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: a SCANS Report for America 2000*. These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

1. Arrange with the local fire department for a presentation about fire safety and how to properly use fire extinguishers. Have students practice a fire drill or a severe weather drill with special attention to reassembly points. **Basic skills, listening; interpersonal skills, teamwork.**
2. Arrange for a school nurse or physician to talk to students about first aid and give a demonstration of how to dress common cuts, punctures, and burns. Try to include a demonstration of resuscitation. **Basic skills, listening and science.**
3. Stress eye safety and the importance of wearing safety glasses when using tools and using a face mask when grinding. Point out the location of the eye flushing station or equipment and demonstrate how to use it. **Personal management skills, responsibility.**
4. Talk about Assignment Sheet 1 and matters of accidents and first aid. Focus on accidents that have happened around the school, how they were handled, and how they could have been prevented. **Basic skills, listening; personal management skills, responsibility.**
5. Collect a variety of MSDS sheets for use with Assignment Sheet 2. Have students work in teams to prepare reports to present before the class, reports reflecting how to use products that they will be using in the class or lab. **Interpersonal skills, teamwork.**
6. Review any special rules or guidelines the school may have for safety or general student conduct. Impress upon students the importance of signing the Student Safety Pledge presented in Assignment Sheet 3. **Personal management skills, responsibility.**

Resources Used in Developing This Unit

1. *The ABCs of Fire Prevention*. Belleville, NJ. Walter Kidde and Co., Inc., 1978.
2. *An Accident Prevention Program for Schools, Shops and Laboratories*. Office of Education/US Department of Health, Education and Welfare.
3. The American Red Cross. *Standard First Aid and Personal Safety*. Garden City, NJ: Doubleday and Co., Inc., 1979.
4. Henderson, John, MD. *Emergency Medical Guide*. New York, NY: McGraw-Hill, 1963.
5. *Kansas State Safety Education Handbook*, Vol. 3. Wichita, KS: Kansas State Department of Education in Cooperation with the Wichita Public Schools, USD 259, 1981.

Suggested Activities

6. *Making Safety Work*. Chicago, IL: National Safety Council.
7. *Safety and Health*. San Francisco, CA: Parlay International, 1988.
8. *Safety on the Job: Some Guidelines for Working Safely*. Stillwater, OK: CIMC/Oklahoma Department of Vocational and Technical Education, 1989.

Suggested Supplemental Resources

1. Videotapes
 - a. *Basic Practices*, 13 minutes
 - b. *Safety Meeting Series 1*, 20 minutes
 - (1) *Lifting*
 - (2) *Eye Protection*
 - (3) *Hand Tool Safety*
 - c. *Safety Meeting Series 2*, 23 minutes
 - (1) *Wearing Safety Gear*
 - (2) *Housekeeping Hazards*
 - (3) *Hand Protection*
 - d. *Safety Meeting Series 4*, 22 minutes
 - (1) *Fire Prevention*
 - (2) *Hazard Awareness*
 - e. *Safety Meeting Series 5*, 21 minutes
 - (1) *Slips, Trips, and Falls*
 - (2) *Protect Your Hearing*
 - f. *Safety Meeting Series 15*, 36 minutes
 - (1) *Commitment to Safety*
 - (2) *Disaster Preparedness*

Suggested Activities

- g. *Avoiding Slips, Trips, and Falls*, 12 minutes
- h. *Back Care and Safety*, 14 minutes
- i. *Eye Care and Safety*, 15 minutes
- j. *Hearing Conservation and Safety*, 13 minutes
- k. *Respiratory Safety and Health*, 12 minutes
- l. *Safety Attitudes and Actions*, 14 minutes
- m. *Selection and Use of Personal Protective Equipment*, 16 minutes
- n. *Back to Basics for Safe Lifting*, 21 minutes
- o. *Fire Extinguishers—The First Responder*, 16 minutes

a-o are available from:

Coronet/MTI Film & Video
Equity Drive
Columbus, OH 43228
800-321-3106, x920

- p. *Minimizing Back Strain*, 24 minutes
- q. *Hand Safety*, 18 minutes
- r. *Hearing Safety*, 18 minutes
- s. *Eye Safety*, 20 minutes
- t. *Portable Fire Extinguisher Safety*, 26 minutes
- u. *Safety: The Big Picture*, 12 minutes
- v. *Avoiding Slips and Falls*, 18 minutes

p-v are available from:

Tel-A-Train
North Market Street
Box 4752
Chattanooga, TN 37405
800-251-6018 or 615-266-0113

Suggested Activities

w. *R.I.P. Harry Speaks*, 20 minutes

x. *Your Guardian Angel*, 15 minutes

w and x are available from:

International Film Bureau, Inc.
S. Michigan Avenue
Chicago, IL 60604-4382
800-432-2241

2. OSHA Fact Sheets

a. *Job Safety and Health*, 93-01

b. *Eye Protection in the Workplace*, 93-03

c. *Protect Yourself with Personal Protective Equipment*, 92-08

d. *Back Injuries-Nation's Number One Workplace Safety Problem*, 93-09

e. *Responding to Workplace Emergencies*, 92-19

f. *Workplace Fire Safety*, 93-41

a-f are available from regional OSHA offices or write to:

Office of Administrative Services
Constitution Ave., NW, Rm. N3101
Washington, DC 20210

3. Safety signs and posters

National Safety Council
Spring Lake Drive
Itasca, IL 60143-3201
800-621-7619 (toll free outside Illinois)

4. The services and more than 140,000 holdings of the National Safety Council's Library are available to the public. Nonmembers are assessed fees for services. The library's phone number is (630) 775-2199, fax (630) 285-0242.

Suggested Activities

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

- 4 Skilled—Can perform job with no additional training.
- 3 Moderately skilled—Has performed job during training program; limited additional training may be required.
- 2 Limited skill—Has performed job during training program; additional training is required to develop skill.
- 1 Unskilled—Is familiar with process, but is unable to perform job.

Option B

- Yes—Can perform job with no additional training.
- No—Is unable to perform job satisfactorily.

**Safety and First Aid
Unit 2**

Answers to Assignment Sheets

Assignment Sheet 1

- A.
 - 1. Clean the cut again.
 - 2. Cover with a dry, sterile dressing.
- B.
 - 1. Nothing: deeply embedded splinters should not be removed.
 - 2. Notify supervisor or instructor.
- C.
 - 1. The student is probably suffering from shock.
 - 2. Treat for shock.
- D.
 - 1. No.
 - 2. Apply another compress over the first one.
- E.
 - 1. Apply a sterile dressing.
 - 2. Bandage loosely and get medical help immediately.
- F.
 - 1. See the most immediate medical attention.
 - 2. Seek the most immediate medical attention.
- G.
 - 1. Make notes about the accident; include name of victim, time, place, cause, or nature of the accident, and any first aid that was administered.
 - 2. Report the accident to your instructor or supervisor.

Assignment Sheet 2

General Section

- A. 2
- B. 2
- C. 1

Bonus Section

Evaluated according to local availabilities and to instructor's satisfaction

Assignment Sheet 3

Evaluated to instructor's satisfaction

**Safety and First Aid
Unit 2**

Written Test

Name _____ Date _____ Score _____

1. Match each term on the right with its correct definition.

- _____ a. State or condition of being safe; freedom from danger, risk, or injury
- _____ b. Any suddenly occurring, unintentional event which causes personal injury or property damage
- _____ c. Immediate, temporary care given the victim of an accident or sudden illness until the service of a physician can be obtained
- _____ d. Points on the body where arteries pass close to the surface of the skin and in front of bone structure so that pressure forcing the artery against the bone can check the flow of blood to a specific part of the body.
- _____ e. Materials or liquids that catch fire easily
- _____ f. The science of good health and its maintenance, including sanitary practices and cleanliness
- _____ g. An acute, infectious disease that usually enters the body through cuts or wounds; characterized by spasmodic contractions or rigidity of some voluntary muscles and frequently referred to as lockjaw
- _____ h. A bandage or strap twisted around a limb to compress the flow of blood through arteries and check severe bleeding; previously a recommended first aid procedure, but now recommended not at all or only in life-threatening situations

- 1. First aid
- 2. Tetanus
- 3. Pressure points
- 4. Hygiene
- 5. Tourniquet
- 6. Safety
- 7. Combustible
- 8. Accident
- 9. MSDS
- 10. Bloodborne pathogen

Written Test

- ____i. A disease-causing microorganism found in infected blood and blood products
- ____j. A form that explains a hazardous material so that employees can use it safely and respond properly to emergency situations.
2. Complete a list of benefits of safe working practices. Circle the word(s) that best completes each statement.
- a. Eliminates the pain or discomfort or personal (**injury**) (**embarrassment**).
 - b. Eliminates the loss of equipment or the expense of (**repair**) (**cleanup**).
 - c. Eliminates lost time and lost (**wages**) (**esteem**).
 - d. Contributes to the psychological well being of (**only the boss**) (**all employees**).
 - e. Contributes to productivity and job (**security**) (**promotions**).
 - f. Fulfills the (**social**) (**moral**) obligation a worker has to employer and fellow employees.
3. Select true statements concerning the major causes of accidents. Place an "X" beside each true statement.
- Note: For a statement to be true, all parts of the statement must be true.
- ____a. Unsafe condition—May be caused by improper design, improper installation, or improper maintenance of a tool, machine, or any piece of equipment.
 - ____b. Unsafe act—The violation of a commonly accepted safe practice.
 - ____c. Combination causes—An unsafe condition combined with an unsafe act causes the fewest accidents.
4. State the motto for good housekeeping.
- _____
5. Complete statements concerning basic rules for safe use of tools and equipment by inserting the word(s) that best completes each statement.
- a. When using a screwdriver, _____ the work on a bench or against a solid surface.

Written Test

- b. When using a wrench, pull it _____ the body to prevent smashing your hand if the wrench should slip.
 - c. Do not strike a mushroomed punch or chisel, pieces of it may strike you in the _____ or the hammer may slip and injure your _____.
 - d. Wear safety _____ when using striking tools.
 - e. Be especially careful of burrs and fish hooks which are left on the edge of _____; they can cause severe cuts.
 - f. Never use a file without a _____; the tang could easily pierce your hand and cause a serious injury.
 - g. When working with a drill press, remove the chuck and _____ the work in place.
 - h. When grinding or polishing, always wear safety _____.
 - i. Never operate a machine from which the _____ have been removed.
 - j. Do not let molten solder come in contact with _____ metal because the solder will blow up in your face and eyes.
 - k. Do not let soldering _____ get on your skin or in your eyes because it can cause serious injury.
 - l. NEVER NEVER use _____ near oxyacetylene welding equipment; the interaction of oxygen and _____ can cause a violent explosion.
 - m. Wear _____ goggles when working with oxyacetylene cutting equipment.
6. Arrange in order the steps in lifting safely. Insert the correct sequence number in the appropriate blank.
- _____ a. Bend your knees, get a good hand hold, then use both legs and back muscles to lift the load straight up as you push with your legs and keep the load close to your body.
 - _____ b. Lower the load by bending your knees, and remember to store heavy objects at least 12" off the floor.
 - _____ c. Size up the load to make sure you can safely handle it alone and then place your feet close to the object and about 12" apart.
 - _____ d. Do not turn or twist until you have the load lifted into a carrying position, and then move your feet to turn your body as you check your path of travel to make sure it's clear.

Written Test

7. Select true statements concerning special lifting rules for appliance repair. Place an "X" beside each true statement.
- ___ a. Heavy appliances such as washers and dryers should always be transported on an appliance dollie and securely tied with a restraining strap.
 - ___ b. An appliance flipper should always be used to turn heavy appliances because it will protect your back, avoid damage to the appliance, and protect a customer's floor.
 - ___ c. In cases where heavy appliances have to be loaded on a truck, always work with a helper unless the truck is equipped with a hydraulic tail gate lift such as a Tommy Lift.
8. Match MSDS information with its details. Place the number beside the MSDS information in the blank beside the detail that explains it.
- | | |
|---|--|
| ___ a. Lists the identity of the substance, the date, the MSDS was prepared, name and address of the manufacturer, and usually a phone number for emergencies | 1. Usage, handling, and storage |
| ___ b. Includes names of substances in the chemical that might be dangerous, safe exposure limits, and common names for the chemical | 2. Physical characteristics |
| ___ c. Describes usual or safe physical qualities such as how it looks or smells, boiling and melting temperatures, evaporation rates, how easily it dissolves, and how heavy it is compared to water | 3. Reactivity |
| ___ d. Identifies flash point, flammability, combustibility and the best way to put out a fire involving the chemical | 4. Chemical name |
| ___ e. Describes what happens if this chemical comes in contact with certain conditions like heat, or chemicals like air, water, or others | 5. Special protection and precautions |
| ___ f. Lists ways the chemical might enter your body, symptoms of overexposure, and emergency first aid procedures | 6. Hazardous ingredients/chemical identity |
| | 7. Fire and explosion data |
| | 8. Health hazards |

Written Test

- ___g. Describes how to clean up an accidental spill, leak, or release, including special precautions; tells how to handle, store, and dispose of chemical safely
- ___h. Explains special personal protective equipment and other equipment to use when working with the chemical and extra health and safety information not covered in other sections.
9. Complete statements about problems and health effects of hazardous chemicals. Insert the word(s) that best completes each of the following statements.
- a. Hazardous chemicals can enter the body by way of _____, absorption, or inhalation.
 - b. Ingestion means the chemical is accidentally _____ or eaten from food that has been touched by someone contaminated with the chemical.
 - c. Absorption means the chemical has contacted the skin or eyes, and all types of acids and _____ are culprits in this form of entry.
 - d. Inhalation means entry by breathing fumes, vapors, or gases, and this often happens to workers confined to small or _____ workplaces.
 - e. Short term effects from a _____ encounter with a hazardous chemical may cause a variety of responses such as pain, nausea, itching skin, burning eyes, headache, or vomiting.
 - f. Long term effects from repeated or _____ exposure to a hazardous chemical may cause a variety of disabling or fatal responses such as kidney damage, emphysema, sterility, or cancer.
 - g. The long term effects are most dangerous because they may not show up until years after the exposure and at a time when their effects cannot be _____; that is why it is important to observe precautions around all hazardous chemicals.
10. Solve problems about the diamond classification system for hazardous materials. Circle the statement that best solves each of the following problems.
- a. A coworker notes that the hazardous materials diamond displayed on a delivery truck has a 2 in the right-side yellow diamond. Your friend comments that the materials are not flammable and probably very safe.
 - (1) The problem is that the coworker is assuming that chemicals that don't burn are safe. Such chemicals may be safe, but the 2 in the yellow diamond indicates that the chemicals on the truck can be subject to violent chemical change.

Written Test

- (2) The problem is that the coworker has not read all the information about the chemical and should assume only that they are relatively safe.
- b. Upon seeing a white diamond with what looks like a propeller in it, a fellow worker comments that the material is corrosive and should be handled with gloves.
 - (1) The problem is that the coworker has underestimated the chemical; working with it requires not only gloves, but a face mask.
 - (2) The problem is that the coworker has incorrectly identified the nature of the hazard. The propeller-like symbol indicates a radiation hazard, and the chemical should be handled only by workers properly dressed and trained to handle a radiation hazard.
- c. In discussing fire hazards, a coworker tells you that the most dangerous chemicals are those which catch fire at very high degree ratings because they may explode or do almost anything.
 - (1) The problem is that the coworker failed to mention that at very high degrees of heat certain chemicals become highly unstable.
 - (2) The problem is that the coworker improperly identified the hazard; the most dangerous chemicals are those that have a low flash point because they catch fire easily and may be deadly because they can detonate.
- 11. Complete statements about fire safety rules. Insert the word(s) that best completes each of the following statements.
 - a. Report immediately anything that might be a _____ fire hazard.
 - b. Know the location and the proper _____ of fire extinguishers and make sure they have been recently checked.
 - c. Know where the nearest _____ is and make sure the _____ of the nearest fire department is listed on the _____, if other than 911.
 - d. Know the procedure for _____ the building and the location of all fire exits in case one or more exits may be blocked.
 - e. Smoke only at _____ times and in _____ areas and make sure cigarette butts are completely extinguished and properly discarded.
 - f. Examine materials and equipment around the workplace to determine what _____ of fires might occur, then make sure available fire extinguishers are correct for the _____ of fires that might occur.
 - g. Isolate _____ materials in fire-resistant areas.
 - h. Dispose of _____ regularly.

Written Test

- i. Conduct fire _____ at regular intervals to make sure the alarm can be heard over shop noises, and that everyone knows evacuation routes, exits, and reassembly points.
- j. Don't _____ anything in _____ of a fire extinguisher.
- k. Know where _____ and _____ cut-offs are located so you can reach them quickly if an emergency demands.

12. Match classes of fires with their causes.

- | | | |
|----------|--|------------------|
| _____ a. | Result from ordinary combustibles such as wood, paper, and cloth | 1. Class B fires |
| _____ b. | Result from flammable liquids such as gasoline, oil, paint, solvents, and grease | 2. Class C fires |
| _____ c. | Result from electrical wires, switches, and motors | 3. Class A fires |

13. Match types of fire extinguishers with their recommended uses.

- | | | |
|----------|--|-------------------------------|
| _____ a. | Recommended only for Class A and Class B fires | 1. Pump tank |
| _____ b. | Recommended only for Class A fires | 2. Soda acid |
| _____ c. | Recommended only for Class A fires | 3. Halon |
| _____ d. | Recommended for all classes of fires | 4. Foam |
| _____ e. | Recommended for only Class B and Class C fires | 5. Multi-purpose dry chemical |
| _____ f. | Recommended for only Class B and Class C fires | 6. Ordinary dry chemical |

Written Test

14. Match types of fire extinguishers with their recommended operations.

- | | | |
|----------|---|----------------------------|
| _____ a. | Allow foam to fall lightly onto the fire, not directly into the fire, especially a burning liquid | 1. Carbon dioxide |
| _____ b. | Get as close to the first as possible, and direct the discharge at the edge of the flames and work gradually forward and upward | 2. Dry chemical |
| _____ c. | Direct the steam at the base of the flames | 3. Foam |
| _____ d. | Direct the steam at the base of the flames, and then directly at material left burning | 4. Soda acid and pump tank |

15. Complete statements concerning special safety requirements for appliance repair. Insert the word(s) that best completes each of the following statements.

- a. Working with washers, dishwashers, and garbage disposers exposes technicians to _____ hazards that demand special attention.
- b. Always make sure the appliance is _____ or _____ from its _____ source before working with water lines or hoses.
- c. When loosening water-carrying connections, hold a shop towel around the connection so water won't spray onto adjacent _____ components.
- d. Drain water into a pan, but do not permit water to drain onto a floor, especially in a _____.
- e. When testing a water-carrying connection that has just been made up, hold a _____ around it until you know it doesn't leak.
- f. Tools exposed to water should be thoroughly dried and _____ before putting them away.
- g. Never set electrical test instruments on a _____ surface.
- h. Make sure all equipment that you install or work on is properly _____.
- i. Use _____ gases with care.
- j. Never direct a _____ in the direction of another worker.

Written Test

16. Complete statements about special rules for eye protection. Insert the word(s) that best completes each of the following statements.
- a. Safety _____ should be worn at all times in the shop.
 - b. Safety _____ with proper shaded lenses must be worn when working with oxyacetylene cutting equipment.
 - c. Safety _____ should be worn when soldering.
 - d. A _____ should be worn when grinding.
 - e. Any form of eye protection worn should be kept _____ so it will not impair the view of materials or the work area.
17. Select true statements about ways to recognize shock. Place an "X" beside each true statement.
- ____ a. Skin looks flushed and reddish.
 - ____ b. Skin may be moist and clammy, even cold to the touch.
 - ____ c. Victim feels weak.
 - ____ d. Pulse is rapid and strong.
 - ____ e. Breathing rate is fast and irregular.
 - ____ f. Victim may be confused or incoherent.
18. Arrange in order the steps in treating shock. Place the correct sequence number in the appropriate blank.
- ____ a. Eliminate the causes of shock, control bleeding, or administer artificial respiration if the victim is not breathing.
 - ____ b. Notify supervisor or instructor IMMEDIATELY.
 - ____ c. DO NOT DELAY immediate first aid treatment; it can be life saving.
 - ____ d. Cover the victim to retain body heat, but do not make victim sweat.
 - ____ e. Give no liquids or food to a shock victim.
 - ____ f. Keep victim lying down with feet slightly elevated.

Written Test

19. Complete statements about first aid for victims of electrical shock. Insert the word(s) that best completes each of the following statements.

- a. Remove the victim from the electrical source or cut off the electrical source as quickly as possible.
 - (1) In a shop area where electrical breakers can be reached quickly, _____ before touching victim.
 - (2) In any situation where the power _____ be shut off, use a dry stick, a rope or leather belt, or a coat or blanket to separate the victim from the source of electricity.
- b. Have someone call for medical assistance _____.
- c. Check victim's breathing and heartbeat:
 - (1) If pulse is present, but _____ has stopped, administer mouth to mouth resuscitation.
 - (2) If _____ has stopped, administer cardiopulmonary resuscitation but only if you have been properly trained.
- d. Treat for shock by keeping the victim _____ with legs raised slightly above the level of the head.
- e. Treat for electrical burns by wrapping the burned area with _____ gauze, and as you treat for burns, cover your mouth with a handkerchief to keep germs away from the burns.
- f. Continue treatment until _____ help arrives.

20. Select true statements concerning first aid guidelines for common workplace injuries. Place an "X" beside each true statement.

- ____ a. Minor cuts should be cleaned with soap and water, rinsed, and covered with a dry, sterile dressing.
- ____ b. Puncture wounds should be immediately bandaged.
- ____ c. Slivers and splinters that do not penetrate deeply should be treated as puncture wounds, but splinters that penetrate deeply should be taken out with tweezers.
- ____ d. Regardless of severity, all cuts, punctures, and splinter injuries should be treated immediately to avoid infection.
- ____ e. Depending on the cause of the cut, puncture, or splinter wound, it is usually wise to consider tetanus a hazard.

Written Test

- ____ f. Report all cuts, punctures, splinter wounds, and abrasions to your supervisor or instructor.
21. Select true statements concerning first aid guidelines for workplace burns. Place an "X" beside each true statement.
- ____ a. Always treat the victim for shock.
- ____ b. In the case of a chemical burn, wash off the chemical with large quantities of running water and cut clothing off the affected area.
- ____ c. In the case of thermal burns, cut away clothing from the area of the burn, but do not try to remove material that adheres to the burn.
- ____ d. With all burns, leave uncovered so air can reach the burn.
22. Arrange in order the steps in controlling bleeding. Place the correct sequence number in the appropriate blank.
- ____ a. Treat for shock.
- ____ b. If there is a severe life-threatening hemorrhage, AND ONLY AS A LAST RESORT, apply a tourniquet.
- ____ c. Elevate the bleeding parts above the heart level unless there is evidence of a fracture.
- ____ d. Place a compress of sterile gauze or the cleanest available material directly over the bleeding site.
- ____ e. Secure compress with a pressure bandage.
- ____ f. If blood soaks through the first compress, place another compress on it, but do not remove the first compress.
- ____ g. Press firmly with fingers or palm of one hand.
23. Complete statements concerning pressure points for checking bleeding: Circle the word(s) that best completes each of the following statements.
- a. Bleeding from the front of the face can often be controlled by pressing the **(femoral) (facial)** artery.
- b. Bleeding from the armpit, or sometimes the entire arm, can often be controlled by pressure on the **(subclavian) (femoral)** artery.
- c. Bleeding from an arm can often be controlled by pressure on the **(brachial) (facial)** artery.

Written Test

- d. Bleeding from a leg can often be controlled by deep pressure on the **(femoral)** **(brachial)** artery.

24. Select true statements concerning first aid for eye injuries. Place an "X" beside each true statement.

Note: For a statement to be true, all parts of the statement must be true.

- ____ a. Every eye injury should receive immediate first aid attention.
- ____ b. Notify your supervisor or instructor immediately.
- ____ c. For an apparent minor object in the eye, have the person wink several times. If the tears produced by winking do not remove the object, assume that the object is imbedded and use the following procedure:
- (1) Have the victim close his or her eyes.
 - (2) Put a piece of moist cotton over the closed lid.
 - (3) Place a bandage over the cotton.
 - (4) Get the victim to a doctor as soon as possible.
- ____ d. When the eyeball has been obviously scratched or penetrated, apply a sterile dressing, a bandage *loosely*, and get medical help immediately.
- ____ e. Never permit the victim of an eye injury to rub his or her eye.
- ____ f. When in doubt about any eye injury, seek the most immediate medical attention whether it's on the job or in the classroom.
- ____ g. Even though damage may be confined to one eye, it is sometimes best to bandage both eyes with a sterile dressing so the victim will not have a tendency to move the damaged eye.
- ____ h. For chemical or acid splashes, flush the eyes repeatedly at an eye-flushing station or use a bottled, portable flushing solution, then seek immediate medical assistance.

25. Complete statements concerning general guidelines for first aid emergencies by inserting the word(s) that best completes each statement.

- a. Never _____ to administer first aid when it is needed.
- b. Always have a _____ for what you do.
- c. _____ the injured person that everything possible is being done.

Written Test

- d. Make accurate _____ about the accident including name of victim, time, place, cause or nature of the accident, and any _____ that was administered.
- e. Do not notify the victim's _____ because this is the responsibility of the school, the jobsite supervisor, or the medical facility.
- f. Report all accidents and injuries to your instructor or jobsite supervisor, no matter how _____ they may seem to be.
- g. File a complete _____ report and submit a copy to the proper persons.

Permission to duplicate this test is granted.

**Safety and First Aid
Unit 2**

Answers to Written Test

1. a. 6 f. 4
 b. 8 g. 2
 c. 1 h. 5
 d. 3 i. 10
 e. 7 j. 9

2. a. injury
 b. repair
 c. wages
 d. all employees
 e. security
 f. moral

3. a, b

4. A place for everything and everything in its place.

5. a. support
 b. toward
 c. eye, hand
 d. goggles
 e. sheet metal
 f. handle
 g. clamp
 h. goggles
 i. guards
 j. wet
 k. acid
 l. oil, oil
 m. cutting

6. a. 2
 b. 4
 c. 1
 d. 3

7. a, b, c

8. a. 4 e. 3
 b. 6 f. 8
 c. 2 g. 1
 d. 7 h. 5

9. a. ingestion
 b. swallowed
 c. cleaning fluids

Answers to Written Test

- d. poorly ventilated
 - e. brief
 - f. prolonged
 - g. reversed
10. a. (1)
b. (2)
c. (2)
11. a. potential
b. operation
c. telephone, number, phone
d. evacuating
e. authorized, authorized
f. types, classes
g. combustible
h. rubbish
i. drills
j. stack, front
k. electrical, gas
12. a. 3
b. 1
c. 2
13. a. 4
b. 1 or 2
c. 1 or 2
d. 5
e. 3 or 6
f. 3 or 6
14. a. 3
b. 1
c. 4
d. 2
15. a. electrical/water
b. unplugged, removed, power
c. electrical
d. customer's home
e. shop towel
f. lubricated
g. wet
h. grounded
i. compressed
j. compressed air hose

Answers to Written Test

16. a. glasses
b. goggles
c. goggles
d. face shield
e. clean
17. b, c, e, f
18. a. 3
b. 1
c. 2
d. 5
e. 6
f. 4
19. a. (1) shut off power
(2) cannot
b. immediately
c. (1) breathing
(2) heartbeat
d. warm
e. sterile
f. medical
20. a, d, e, f
21. a, b, c
22. a. 6
b. 7
c. 3
d. 1
e. 5
f. 4
g. 2
23. a. facial
b. subclavian
c. brachial
d. femoral
24. a, b, c, d, e, f, g, h
25. a. hesitate
b. reason
c. reassure
d. notes, first aid
e. family
f. minor
g. accident

**Safety and First Aid
Unit 2**

Unit Evaluation Form

Student Name _____ Date _____ Unit Rating _____

Assignment Sheet Ratings

Assignment Sheet 1—Select Proper First Aid Procedures Rating _____

Comments: _____

Assignment Sheet 2—Solve Problems about Hazardous Materials Rating _____

Comments: _____

Assignment Sheet 3—Sign a Student Safety Pledge Rating _____

Comments: _____

Written Test Scores

Pretest _____ Posttest _____ Other _____

Other _____

Teacher Signature _____ Date _____

Student Signature _____ Date _____

Permission to duplicate this form is granted.

**Fundamentals of Electricity
Unit 3**

Unit Contents

Teacher Components

	Teacher Page
1. Suggested Activities	
a. Instructional Plan-----	1
b. Teaching Suggestions-----	2
c. Resources Used in Developing This Unit-----	2
d. Suggested Supplemental Resources-----	3
e. Instructions for Evaluating Student Performance-----	4
2. Transparency Masters	
TM 1—Electrical Transmission-----	5
TM 2—Ohm's Law—Computing Voltage-----	7
TM 3—Ohm's Law—Computing Current-----	8
TM 4—Ohm's Law—Computing Resistance-----	11
TM 5—Voltage Drops in a Circuits-----	13
3. Answers to Assignment Sheets-----	15
4. Written Test-----	17
5. Answers to Written Test-----	29
6. Unit Evaluation Form-----	33

Student Components

1. Objective Sheet	MAR-49
2. Information Sheet	MAR-51
3. Student Supplements	
Student Supplement 1—Electrical Transmission	MAR-67
Student Supplement 2—Electricity From Friction	MAR-69
Student Supplement 3—Electricity From Chemical Action	MAR-71
Student Supplement 4—Electricity From Magnetism	MAR-73
Student Supplement 5—Electricity From Light.....	MAR-75
Student Supplement 6—Electricity From Heat.....	MAR-77
Student Supplement 7—Electricity From Pressure	MAR-79
Student Supplement 8—Insulators, Semiconductors, and Conductors	MAR-81
Student Supplement 9—Basic Circuit	MAR-83
Student Supplement 10—Resistor Color/Value Chart.....	MAR-85

Unit Contents

4. Assignment Sheets

AS 1—Solve Problems For An Unknown Voltage	MAR-87
AS 2—Solve Problems For an Unknown Amperage	MAR-89
AS 3—Solve Problems For an Unknown Resistance	MAR-91
AS 4—Identify Resistor Values Using a Standard Color Code.....	MAR-93

Fundamentals of Electricity Unit 3

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction or individual learning activities. Study the specific objectives to determine the order in which you will present the objectives.
2. Review Teaching Suggestions section that follows. Plan for classroom activities.
3. Plan enrichment of exceptional students as well as accommodation of special needs students.
4. Add overheads or other graphic materials as desired to enhance instruction, and reinforce noted objectives with the following transparencies:

TM 1—Electrical Transmission (Objective 2)

TM 2—Ohm's Law—Computing Voltage (Objective 18)

TM 3—Ohm's Law—Computing Current (Objective 18)

TM 4—Ohm's Law—Computing Resistance (Objective 19)

TM 5—Voltage Drops in a Circuit (Objective 21)

5. Develop teaching plan. Adjust for different learning styles.
6. Make copy of the Unit Evaluation Form for each student.

Delivery and Application

7. Provide student with unit of instruction.
8. Discuss unit and specific objectives.
9. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic skills when applicable.
10. Discuss and demonstrate, as necessary, activities in the assignment sheets. Review criteria for evaluating these activities.

Evaluation

11. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.
12. Make copies of written test. Add or modify test items as needed.
13. Give written test.

Suggested Activities

14. Compile assignment sheet ratings and written test scores on the Unit Evaluation Form. Include any additional assignment or job sheets added to the unit.
15. Reteach and retest as required.

Teaching Suggestions

Note: Skill areas appearing in boldface in the Teaching Suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000*. These SCAN skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

1. Make a tour of your own classroom/lab to show students where electrical entrances are located and identify them by type. Talk to the class about the generating source for electricity delivered to your community and school. **Basic skills, science and listening.**
2. Invite a representative of your local utility to talk to the class about the types of power supplied to your community and the difference in the kind of power sent to industries and residences. **Basic skills, listening.**
3. Use TMs 2, 3, and 4 to enhance Objectives 16, 17, and 18. Impress upon students the importance of Ohm's law and the importance of being able to make proper electrical measurements in troubleshooting appliance troubles. Use a trainer or other device to give good demonstrations of how Ohm's law is used to determine unknown quantities in circuits. **Basic skills, math and science.**
4. When discussing Kirchhoff's law in Objective 21, reinforce the discussion with Objective 5, and point out the importance of Kirchhoff's law in some forms of electrical troubleshooting. **Basic skills, math and science.**

Resources Used in Developing This Unit

1. Vorderstrasse, Ron. *General Electronic Technician*. Stillwater, OK 74074: Mid-American Vocational Curriculum Consortium, 1986.
2. Lider, Larry. *Really Basic Electricity*. Honeywell, 1982.
3. Baker, Gus E. and Leonard R. Crow. *Electricity Fundamentals*. Indianapolis, IN 46206: Howard W. Sams & Co., Inc., 1971.
4. Burban, Peter and Marshall L. Schmitt. *Understanding Electricity and Electronics*. New York, McGraw-Hill, Inc., 1975.
5. Lister, Eugene C. *Electric Circuits and Machines*. New York: McGraw-Hill, 1975.
6. Bacon, Bill and Mack Sutton. *Major Appliance Repair*. Austin, TX 78712: The University of Texas at Austin, 1983.

Suggested Activities

Suggested Supplemental Resources

1. The Carrier Corporation's *Introduction to Electricity* is a full-color learning module out of Carrier's general training program materials. The module is specifically designed to introduce students who have limited knowledge of electricity to Ohm's law, power, and series and parallel circuits.
2. *Electrical Components and Their Symbols* is another excellent full-color module from Carrier's training program. The module introduces students to AC theory, magnetism, and common electrical components. It also presents basic wiring diagrams to introduce students to circuitry.
3. Carrier training materials are available with quantity discounts to vocational schools, trade associations, and other organization. See your local Carrier dealer for more information, or write:

Literature Services, Bldg. TR-8
P.O. Box 4808
Syracuse, NY 13221

or FAX Carrier at 315-432-3418

Suggested Activities

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

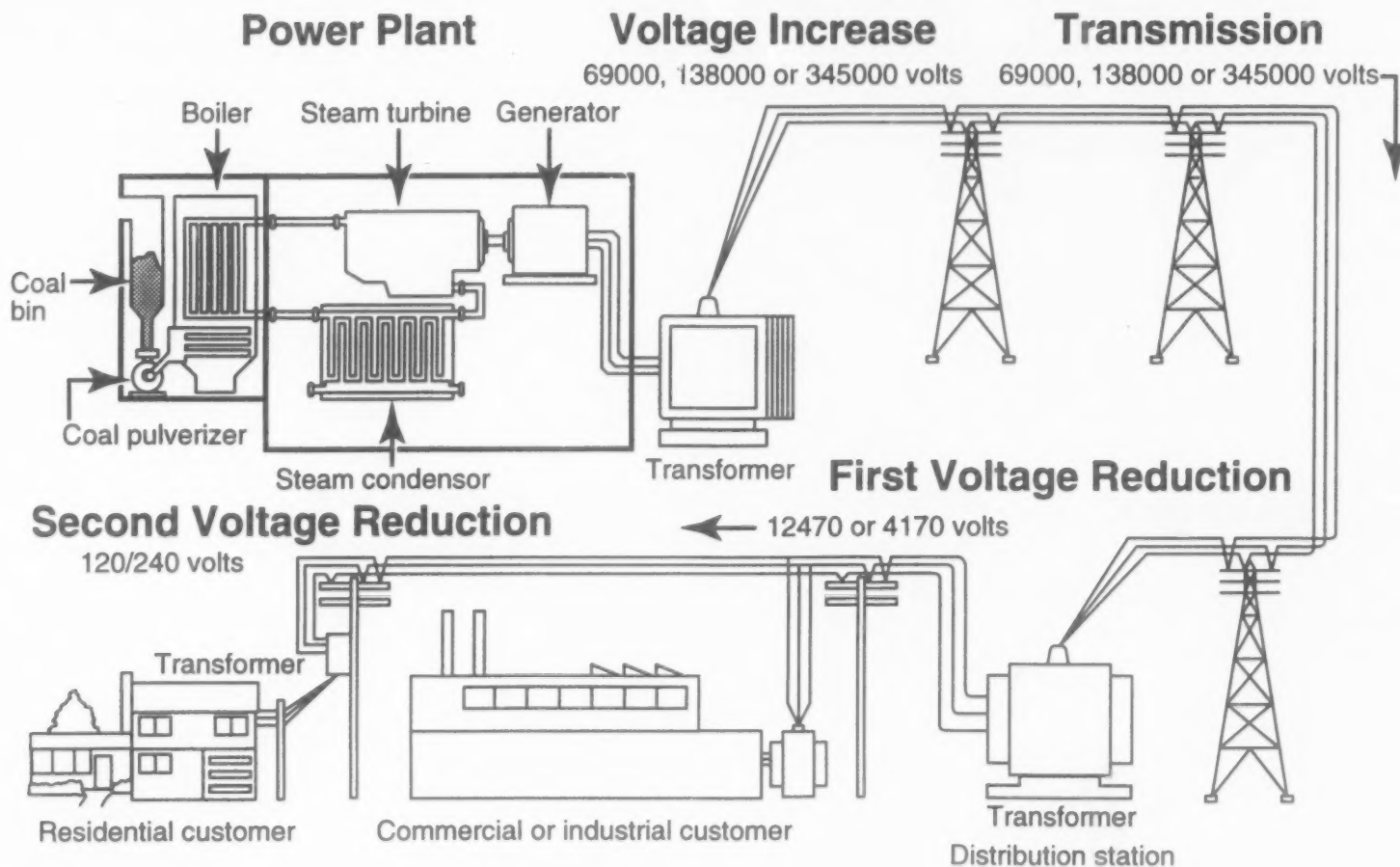
Option A

- 4 Skilled—Can perform job with no additional training.
- 3 Moderately skilled—Has performed job during training program; limited additional training may be required.
- 2 Limited skill—Has performed job during training program; additional training is required to develop skill.
- 1 Unskilled—Is familiar with process, but is unable to perform job.

Option B

- Yes—Can perform job with no additional training.
- No—Is unable to perform job satisfactorily.

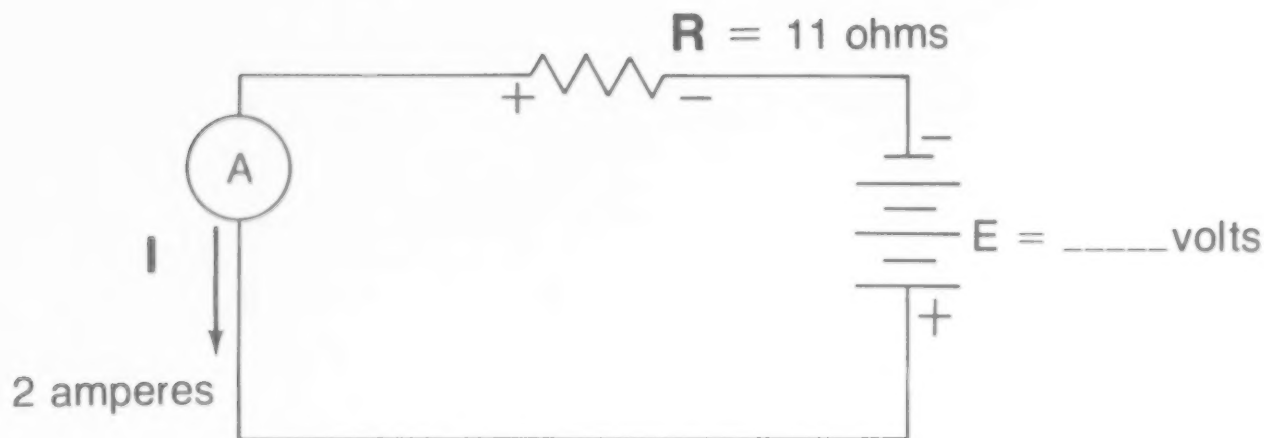
Electrical Transmission



Major Appliance Repair, Unit 3
Teacher Page 5

TM1

Ohm's Law—Computing Voltage

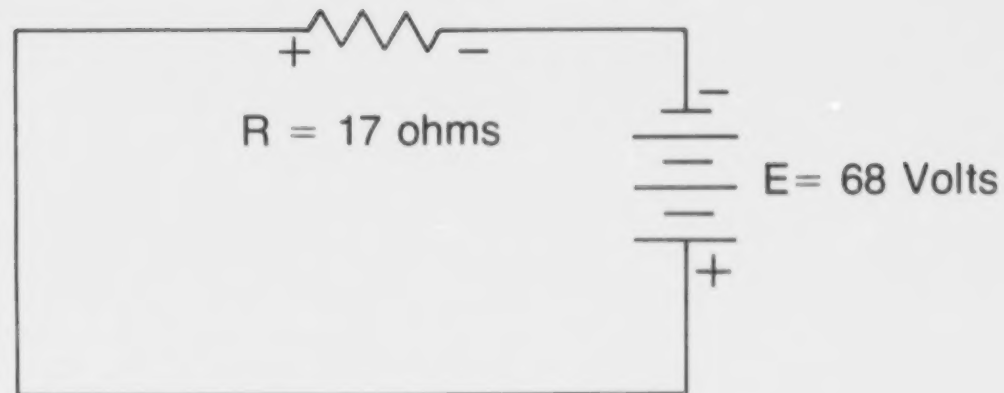


What voltage is being supplied by the battery?

$$E = IR \quad E = 2 \text{ amperes} \times 11 \text{ ohms}, E = 22 \text{ volts}$$

The value of the voltage being supplied by the battery is 22.

Ohm's Law—Computing Current



I = _____ amps

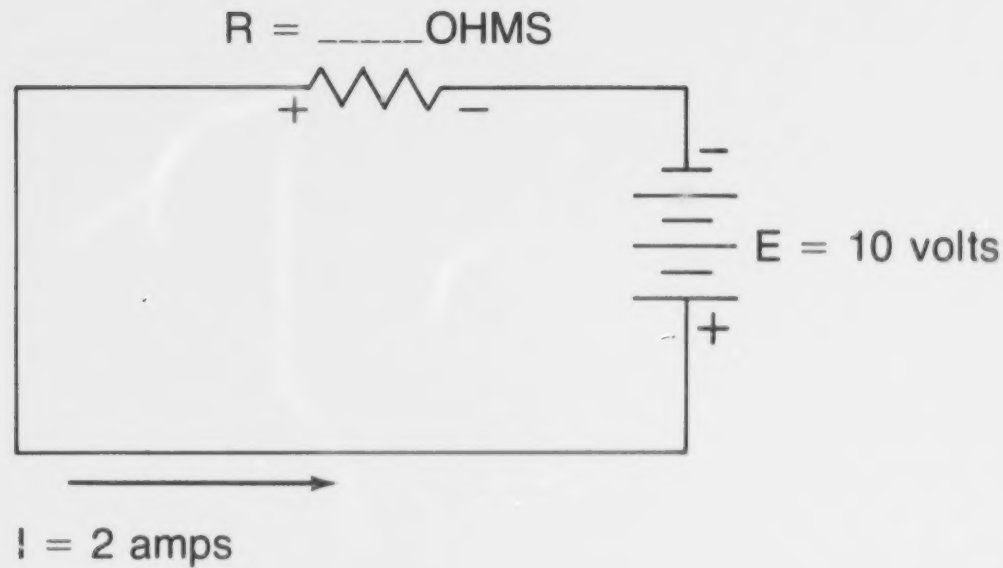
How many amperes of current are flowing in this circuit?

$$E = IR$$

$$I = \frac{E}{R}$$

$$I = \frac{68 \text{ volts}}{17 \text{ ohms}} = 4 \text{ amperes}$$

Ohm's Law—Computing Resistance



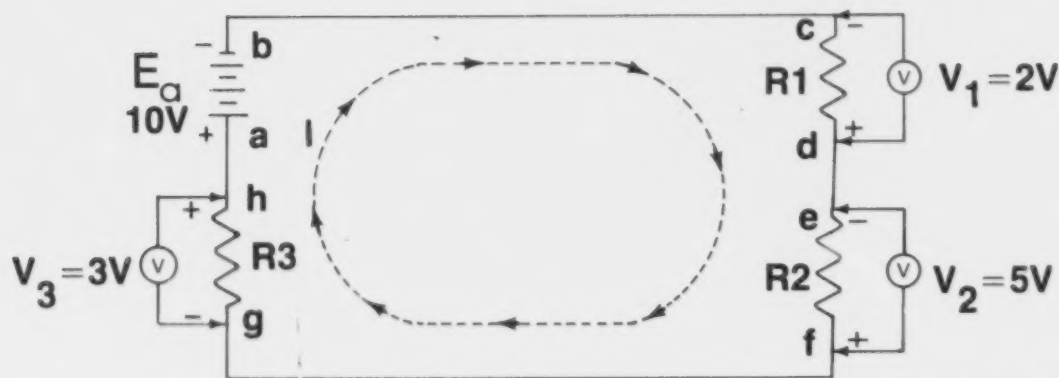
What is the resistance value of the resistor in this circuit?

$$E = IR$$

$$R = \frac{E}{I}$$

$$R = \frac{10 \text{ volts}}{2 \text{ amperes}} = 5 \text{ ohms}$$

Voltage Drops in a Circuit



Applied Voltage (E) = 10V

Direction of Electron Flow: Negative (b) to
Positive (a)

Application of Kirchhoff's Law of Voltage:

$$V_1 + V_2 + V_3 = E$$

$$2V + 5V + 3V = 10V$$

**Fundamentals of Electricity
Unit 3**

Answers to Assignment Sheets

Assignment Sheet 1

1. 120V
2. 240V
3. 24V
4. 15V
5. 12V

Assignment Sheet 2

1. 20A
2. 10A
3. 22A
4. 4A
5. 8A

Assignment Sheet 3

1. 60Ω
2. 2.5Ω
3. 2.4Ω
4. 46Ω
5. 3Ω

Assignment Sheet 4

Evaluated to the satisfaction of the instructor

Fundamentals of Electricity
Unit 3

Written Test

Name _____ Date _____ Score _____

1. Match each term on the right with its correct definition.

- | | | |
|----------|---|-------------------|
| _____ a. | A circuit in which there is a complete and unbroken path for current to flow | 1. Short circuit |
| _____ b. | A circuit in which the path for current has been broken | 2. Closed circuit |
| _____ c. | A circuit in which the current has been diverted from its intended path into a side current of lower resistance | 3. LED |
| _____ d. | A device to which electrical energy is being supplied and used | 4. Open circuit |
| _____ e. | A low voltage bulb used to illuminate numbers and other forms on control panels and other displays | 5. Load |

2. Complete statements about electricity. Insert the word(s) that best completes each of the following statements.

- a. Electricity is a form of energy that can be converted to light, heat, or mechanical energy to perform useful _____.
- b. Electricity exists in nature as _____ electricity and as _____, but these forms of electricity do not perform useful work.
- c. Electricity used for domestic and industrial purposes is generated at power plants and transmitted by high voltage _____ to towns and cities.
- d. High voltage electricity from a generating plan usually has to go through a _____ that steps it down to a lower voltage for home and industry use.
- e. Electricity is put to work in the average home in an arrangement of _____ circuits to supply electricity for lighting, heating, air conditioning, and appliance use.
- f. To benefit people, electricity has to be _____, and switches, solenoids, transformers and other control devices are what make major appliances useful tools for modern living.

Written Test

- 3 Match sources of electricity with their characteristics. Place the number beside the source in the blank beside its characteristic.

- | | | |
|---------|---|---------------------------|
| _____a. | Produces static electricity when two materials are rubbed together | 1. Magnetism |
| _____b. | Produces direct current electricity in batteries and cells when dissimilar elements are placed in a chemical which acts upon them | 2. Mechanical pressure |
| _____c. | Produces direct current or alternating current electricity by moving a conductor through a magnetic field | 3. Friction |
| _____d. | Produce electricity when light strikes them | 4. Heat |
| _____e. | Produces electricity when it is applied to two dissimilar metals that are next to each other | 5. Chemical reaction |
| _____f. | Produces electricity when applied to certain crystalline substances | 6. Photoelectric surfaces |

- 4 Select true statements about the electron theory. Place an "X" beside each true statement.

- | | |
|---------|---|
| _____a. | Neutrons with no charges and ions with positive charges make up the nucleus of an atom. |
| _____b. | Electrons with negative charges orbit the nucleus in paths that are called shells. |
| _____c. | Electrons that orbit in inner shells are attracted to the nucleus, but electrons in the outer shell or "valence" shell can be set free. |
| _____d. | When energy is applied to the centrifugal force in an electron, the electron leaves its previous orbit and moves to a lower orbit. |
| _____e. | Since a valence electron has no higher orbit, it will leave the parent atom and move to another atom. |
| _____f. | The positive charge of an electron freed from the valence shell is the basic unit of electricity. |

Written Test

5. Complete statements about the importance of electrical charges. Insert the word(s) that best completes each of the following statements.
- a. A man named Coulomb experimented with electrical charges and formulated a law that governs the interaction of _____ and _____ charges.
 - b. The two most important electrical relationships established by Coulomb's law are that:
 - (1) Like charges _____.
 - (2) Unlike charges _____.
 - c. The fact that positive charges attract negative charges is extremely important to the movement of _____ required to create current flow in a conductor.
 - d. The attraction and repulsion principles help make DC and AC _____ work.
6. Complete statements about how electron flow is created in a conductor. Circle the word(s) that best completes each of the following statements.
- a. To create electron flow requires a source of already energized electrons like those found in **(a battery)** **(silicon)**.
 - b. The wire or medium that serves as a **(conductor)** **(transmitter)** must have one end connected to the negative side of the power source and the other end connected to the positive side of the power source.
 - c. The **(positive)** **(negative)** charges from the power source energize the negative charges in the conductor and cause them to start moving.
 - d. The **(positive)** **(negative)** charges at the other end of the power source attract the electrons from the negative side and reinforce electron flow.
 - e. The presence of negative charges at one end of the conductor and the absence of negative charges at the other end of the conductor sets up a situation called a **(potential difference)** **(inductance)**.
 - f. The **(potential difference)** **(inductance)** must be present before electrons will flow in a conductor to create electric current that can be put to work.
7. Solve problems about conductors, insulators, and semiconductors.
- a. Would a piece of copper wire be considered a conductor, an insulator, or a semiconductor?

Answer _____

Written Test

- b. Would a silicon disc be considered a conductor or a semiconductor?

Answer _____

- c. Would gold or silver make good insulators?

Answer _____

- d. Would glass make a good insulator?

Answer _____

8. Complete statements about direct current. Circle the word(s) that best completes each of the following statements.

- a. The **(strongest)** **(most common)** source of direct current electricity is the battery.

- b. Both wet and dry cell batteries operate on the same principle of two **(similar)** **(dissimilar)** metals placed in a chemical that reacts upon them.

- c. Chemical reaction in a battery creates **(a potential difference)** **(an inductance)** between the dissimilar elements and creates a condition for electron flow.

- d. Potential difference is also called **(“amperage”)** **(“voltage”)** and can be tapped into with wires and directed to an electrical device or “load”.

- e. The essential characteristic of direct current is that the strength of the current may rise or fall, but it never becomes **(negative)** **(positive)**.

- f. When plotted graphically to depict its movement in time, direct current may be:

(1) **(nonfluctuating)** **(slanted)**.

(2) **(pulsating)** **(intermittent)**.

(3) **(fluctuating)** **(sporadic)**.

- g. Direct current is **(often)** **(seldom)** used with major appliances, but batteries are an excellent source of power for the study of electrical circuits and electrical measurements.

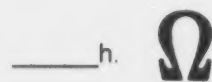
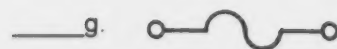
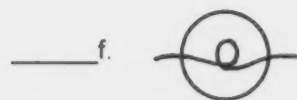
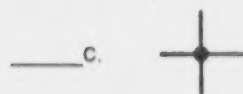
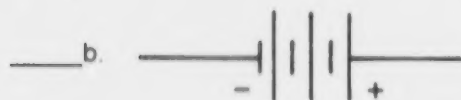
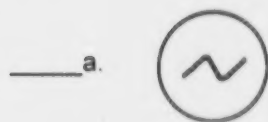
9. Complete statement about alternating current. Insert the word(s) or figures(s) that best completes each of the following statements.

- a. The essential characteristic of alternating current is that it constantly _____ itself above and below a zero base line.

Written Test

- b. When alternating current is depicted graphically in time, it creates a wave form that starts at _____, rises to a maximum level, returns to _____, then reaches another maximum level below _____ base line, and then repeats the alternation.
- c. One complete reversal of alternating current is called a _____, and one _____ contains two different current directions.
- d. Most household current reverses itself _____ times per second, so there are 60 cycles per second or 60 hertz per second.
- e. Alternating current can be transmitted from generating sources over _____ distances without excessive power loss, and it is preferred over direct current.

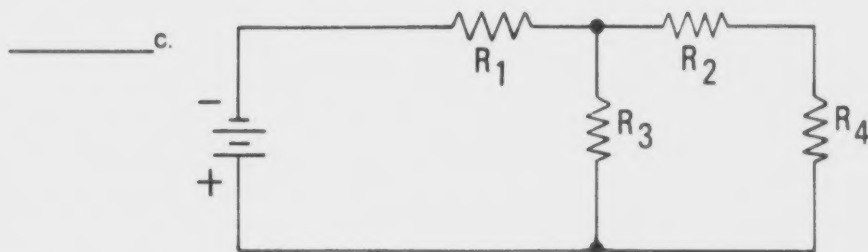
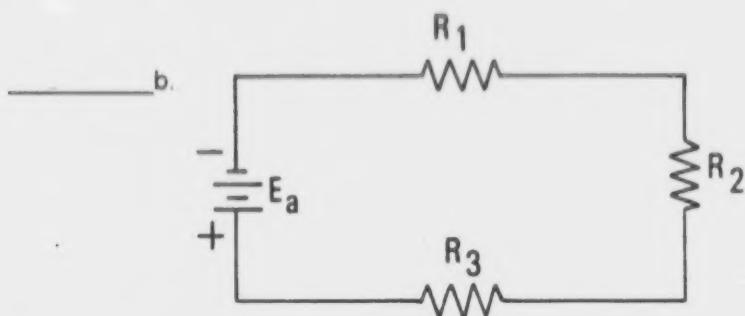
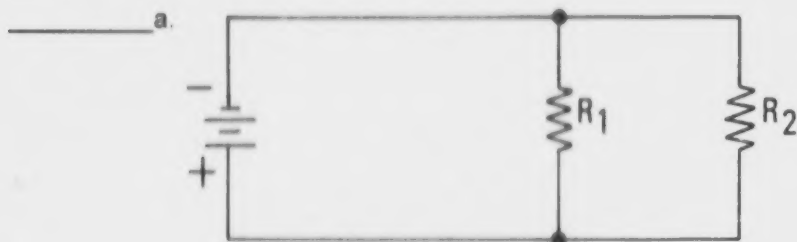
10. Identify basic electrical symbols. Place the number beside the name in the blank beside its illustration.



1. Resistor
2. Ohms
3. An AC power source
4. An open switch
5. A single pole, single throw switch
6. Connected electrical wires
7. Fuse
8. Light or lamp
9. DC power source

Written Test

11. Identify types of circuits. Write the appropriate name beside each of the following circuit diagrams.



12. Complete a list of elements of a basic circuit. Insert the word(s) that best completes each of the following statements.

a. A complete circuit must have:

- (1) A _____ such as a battery.
- (2) A _____ such as an electric wire.
- (3) A _____ such as a light bulb.

Written Test

- b. To be of practical use, a circuit should also have:
- (1) A _____.
 - (2) A _____ device such as a fuse or a circuit breaker.
13. Complete statements about circuit applications. Circle the word(s) that best completes each of the following statements.
- a. Switches are always wired in **(series)** **(parallel)** with the circuits they control.
 - b. Series circuits are used in several appliances such as automatic dryers where the door switch is in series with the motor circuit so the appliance will not start if the **(door is open)** **(fuse is blown)**.
 - c. Parallel circuits are most common in **(washers)** **(house wiring)**, but are also common in refrigerators and ranges.
 - d. In an automatic washer, the fill valve is in **(parallel)** **(series)** with the water level switch so water will cut off at the predetermined level, but the fill valve is in **(parallel)** **(series)** with the timer so the dishwasher will go into a wash cycle after filling.
14. Select true statements concerning circuit grounding. Place an "X" beside each true statement.
- ____ a. A ground in a circuit serves to protect operators and technicians against hazardous static electrical shock.
 - ____ b. All circuits should be grounded with a ground wire from the power source to a point on the appliance chassis.
 - ____ c. In cases where a circuit cannot be grounded to chassis, the ground wire should be secured to a cold water pipe or to a grounding rod driven into the ground.
 - ____ d. Loose grounds create static in radio and television sets and contribute to heat build-up in appliances.
15. Select true statements about electrical measurements. Place an "X" beside each true statement.
- ____ a. Being able to measure the electrical characteristics in a circuit is the basis of all electrical troubleshooting.
 - ____ b. Electrical measurements permit duplication of previous conditions.
 - ____ c. Electrical measurements permit the comparison of a present electrical condition with a past condition.

Written Test

- _____d. Electrical measurements are made with specialized instruments, and knowing how to use test instruments properly is a basic requirement for appliance repair technicians.
16. Match abbreviations with their meanings in Ohm's law. Place the number beside the abbreviation in the blank beside its meaning.
- | | | |
|---------|----------------------------------|------|
| _____a. | Electromotive force in volts | 1. R |
| _____b. | Intensity of the current in amps | 2. E |
| _____c. | Resistance in ohms | 3. P |
| _____d. | Power in watts | 4. I |
17. Complete statements about Ohm's law for electrical circuits. Insert the word(s) that best completes each of the following statements.
- The voltage required to force a given amount of current through a circuit is equal to the current times the _____.
 - The current in a circuit is equal to the voltage divided by the _____.
 - The resistance of a circuit is equal to the voltage divided by the _____.
18. Solve problems using Ohm's law to find unknown values in a circuit. Apply Ohm's law as needed and write the answer in the blank provided.
- Since $E = IR$, a circuit with 20 amps and 6 ohms resistance would have how many volts?
Answer _____
 - Since $I = E/R$, a circuit with 240 volts and 12 ohms resistance would have how many amps?
Answer _____
 - Since $R = E/I$, a circuit with 240 volts and 4 amps would have how many ohms resistance?
Answer _____

Written Test

19. Complete statements about characteristics of electrical power. Write the correct answers in the blanks provided.
- a. Name the fundamental unit of measure for electrical power, and also name the instrument used to measure power.
- Answer _____
- b. How is power made evident?
- Answer _____
20. Complete a list of ways Ohm's law is used. Insert the word(s) that best completes each of the following statements.
- a. To calculate circuit _____
- b. To calculate circuit _____
- c. To calculate circuit _____
- d. To calculate circuit _____
- e. To calculate _____
21. Differentiate between Kirchhoff's laws for voltage and current. Place an "X" beside the statement that describes the law for voltage.
- _____ a. The sum of the voltage drops in a closed loop circuit is equal to the applied voltage.
- _____ b. The algebraic sum of currents into any point in a circuit is equal to the algebraic sum of currents out of that point.
22. Complete statements about working with resistors. Insert the word(s) that best completes each of the following statements.
- a. Resistors are used in some major appliance circuitry to limit current or provide a _____ to establish proper circuit voltage.
- b. Knowing how to read the value of resistors is essential in _____ circuit problems.
- c. Some wire-wound resistors have their value _____ on the body and are easy to determine.

Written Test

- d. Most carbon-composition and film-type resistors can be only be evaluated by use of a _____, and understanding the _____ is essential to resistor troubleshooting.
23. Arrange in order the steps in using the color code to determine resistor value. Insert the correct sequence number in the appropriate blank.
- _____ a. List the first color band as the first number of the resistance value.
 - _____ b. Use the fourth-color band to determine the tolerance of the resistor.
 - _____ c. Always begin with the color band nearest the end of the resistor.
 - _____ d. Use the third color band as the multiplier.
 - _____ e. List the second color band as the second number of the resistance value.

Permission to duplicate this test is granted.

Fundamentals of Electricity
Unit 3

Answers to Written Test

1.
 - a. 2
 - b. 4
 - c. 1
 - d. 5
 - e. 3
2.
 - a. work
 - b. static, lightning
 - c. power lines
 - d. transformer
 - e. parallel
 - f. controlled
3.
 - a. 3
 - b. 5
 - c. 1
 - d. 6
 - e. 4
 - f. 2
4. a, c, d, f
5.
 - a. negative, positive
 - b. (1) repel
(2) attract
 - c. electrons
 - d. motors
6.
 - a. a battery
 - b. conductor
 - c. negative
 - d. positive
 - e. potential difference
 - f. potential difference
7.
 - a. A conductor
 - b. A semiconductor
 - c. No
 - d. Yes
8.
 - a. most common
 - b. dissimilar
 - c. a potential difference
 - d. "voltage"
 - e. negative

114

Answers to Written Test

- f. 1) nonfluctuating
2) pulsating
3) fluctuating
g. seldom
9. a. reverses
b. zero, zero, zero
c. cycle, cycle
d. 120
e. long
10. a. 3. f. 8
b. 9 g. 7
c. 6 h. 2
d. 4 i. 5
e. 1
11. a. Parallel
b. Series
c. Series-parallel
12. a. (1) power source
(2) conductor
(3) load
b. (1) switch
(2) protection
13. a. series
b. door is open
c. house wiring
d. series, parallel
14. a, b, c, d
15. a, b, d
16. a. 2
b. 4
c. 1
d. 3
17. a. resistance
b. resistance
c. current
18. a. 120V
b. 20 amps
c. 60 ohms

115

Answers to Written Test

19. a. The watt, a wattmeter
b. A voltage drop across the resistance

20. a. resistance
b. amperage
c. voltage
d. wattage

Note: a through d may be in any order.

- e. voltage drop

21. a

22. a. load
b. troubleshooting
c. stamped
d. color code, code

23. a. 2
b. 5
c. 1
d. 4
e. 3

**Fundamentals of Electricity
Unit 3**

Unit Evaluation Form

Student Name _____ Date _____ Unit Rating _____

Assignment Sheet Ratings

Assignment Sheet 1—Solve Problems for an Unknown Voltage Rating _____

Comments: _____

Assignment Sheet 2—Solve Problems for an Unknown Amperage Rating _____

Comments: _____

Assignment Sheet 3—Solve Problems for an Unknown Resistance Rating _____

Comments: _____

Assignment Sheet 4—Identify Resistor Values Using a Standard Color Code Rating _____

Comments: _____

Written Test Scores

Pretest _____ Posttest _____ Other _____

Other _____

Teacher Signature _____ Date _____

Student Signature _____ Date _____

Permission to duplicate this form is granted.

**AC Induction Motors
Unit 4**

Unit Contents

Teacher Components

	Teacher Page
1. Suggested Activities	
a. Instructional Plan.....	1
b. Teaching Suggestions.....	2
c. Resources Used in Developing This Unit	2
d. Suggested Supplemental Resources	3
e. Instructions for Evaluating Student Performance	3
2. Written Test	5
3. Answers to Written Test.....	19
4. Unit Evaluation Form	23

Student Components

1. Objective Sheet	MAR-97
2. Information Sheet	MAR-99
3. Job Sheets	
JS 1—Troubleshoot an AC Induction Motor For Thermal Overload	MAR-117
JS 2—Troubleshoot an AC Induction Motor to Determine Whether the Start Mechanism or the Start Windings are Bad, and Replace a Centrifugal Switch	MAR-119
JS 3—Bench Test a Single-Speed Motor With a Test Cord.....	MAR-123

AC Induction Motors Unit 4

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction or individual learning activities. Study the specific objectives to determine the order in which you will present the objectives.
2. Review Teaching Suggestions section that follows. Plan for classroom activities.
3. Plan enrichment of exceptional students as well as accommodation of special needs students.
4. Add overheads or other graphic materials as desired to enhance instruction.
5. Develop teaching plan. Adjust for different learning styles.
6. Make copy of the Unit Evaluation Form for each student.

Delivery and Application

7. Provide students with unit of instruction.
8. Discuss unit and specific objectives.
9. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic skills when applicable.
10. Discuss and demonstrate activities in the job sheets. Review criteria for evaluating these activities.

Evaluation

11. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.
12. Make copies of written test. Add or modify test items as needed.
13. Give written test.
14. Complete assignment sheet ratings and written test scores on the Unit Evaluation Form.
15. Reteach and retest as required.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface in the Teaching Suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: a SCANS Report for America 2000*. These SCAN skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

1. Have some magnets available when you start discussing the principles of magnetism in Objective 2. Have students handle the magnets and match up the opposite poles so they will physically see how like charges repel and unlike charges attract. **Basic skills, science.**
2. Have transformers on hand to show how they are constructed, and then point out how a transformer is installed in an appliance to service a specific component. **Basic skills, science.**
3. Take an AC induction motor apart to help reinforce the materials in Objectives 9, 10, 11, 12, and 13. Display components as you talk about them, and have students examine the components so they will literally have a better "feel" of AC induction motors. **Basic skills, science.**
4. As students discuss motor safety in Objective 22, demonstrate how to use a VOM for checking motor resistance, and how to protect the meter when checking ohms. Relate Ohm's law as presented in a previous unit to the checks that students will be required to make in the job sheets in this unit. **Basic skills, listening, science, and math.**

Resources Used in Developing This Unit

1. Clemons, Mark. *ACR Electrical Systems*. Stillwater, OK 74074: The Mid-America Academic and Vocational Curriculum Consortium, 1997.
2. Vorderstrasse, Ron. *General Electronic Technician*. Stillwater, OK 74074: Mid-America Vocational Curriculum Consortium, 1988.
3. Bacon, Bill and Mack Sutton. *Major Appliance Repair*. Austin, TX 78712: The University of Texas at Austin, 1983.
4. Kaiser, Joe. *Electrical Power*. South Holland, IL: The Goodheart Willcox Company, Inc., 1982.

Suggested Activities

Suggested Supplemental Resources

Carrier's modular-based general training program *Motor Fundamentals and Motor Protection* is an excellent supplement for this unit. Illustrations in the module are in full color and further enhanced with available VHS videos, slide/audio programs, and cassette tapes. The Carrier ID number is GTE2-7. For information, the Carrier FAX is 315-432-3418, or write to:

Carrier
Literature Services Bldg. TR-8
P.O. Box 4808
Syracuse, NY 13221

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

- 4 Skilled—Can perform job with no additional training.
- 3 Moderately skilled—Has performed job during training program; limited additional training may be required.
- 2 Limited skill—Has performed job during training program; additional training is required to develop skill.
- 1 Unskilled—Is familiar with process, but is unable to perform job.

Option B

- Yes—Can perform job with no additional training.
- No—Is unable to perform job satisfactorily.

**AC Induction Motors
Unit 4**

Written Test

Name _____ Date _____ Score _____

1. Match each term on the right with its correct definition.

- | | | |
|----------|---|-----------------------|
| _____ a. | A mechanical switch used to disconnect starting mechanisms in induction motors by taking advantage of the force created by a rotating motor shaft | 1. Magnet |
| _____ b. | A soft iron core that temporarily becomes a magnet when electrical current flows through wires coiled around it | 2. SPST |
| _____ c. | The process of magnetizing an object by bringing it into the magnetic field of an electromagnet or a permanent magnet | 3. Rotor |
| _____ d. | Any device or material that has the properties of magnetism | 4. Reversible motor |
| _____ e. | A mechanical device that has to be manually pressed down to complete a circuit | 5. Centrifugal switch |
| _____ f. | A device used to direct start an induction motor | 6. Momentary switch |
| _____ g. | A load on a circuit or system greater than the load for which it was designed | 7. SF |
| _____ h. | A reference to a motor type that has both start and run windings. | 8. Motor test cord |
| _____ i. | A single lever that operates a single set of contacts | 9. Electromagnet |
| _____ j. | A single lever that operates two sets of contacts | 10. Stator |
| | | 11. Induction |
| | | 12. Duty rating |
| | | 13. SPDT |
| | | 14. Overload |
| | | 15. Pole |
| | | 16. Split-phase |

Written Test

- ____k. A motor wired in a manner that permits external control of polarity so the direction of motor rotation can be reversed
- ____l. The soft, laminated iron portion of a stator around which wire is wound
- ____m. The degree to which a motor can be loaded beyond its rated horsepower
- ____n. The length of time a motor can be safely operated, expressed as continuous or intermittent
- ____o. The iron core cylinder that rotates within the stator of an AC induction motor
- ____p. The component in an AC induction motor that contains the stationary parts of the magnetic circuit and their associated windings
2. State the principles of magnetism. Write in the correct answer to each of the following questions.
- a. What is the name of the magnetic force that forms a field around a magnet?
Answer _____
- b. What do like charges do?
Answer _____
- c. What do unlike charge do?
Answer _____
3. Apply the left hand rule for conductors. Insert the word(s) that best completes the following statements.
- a. Using the left hand rule for conductors is the best way to determine the direction of the lines of _____

Written Test

- b. When the conductor is grasped with the left hand and the thumb is pointing in the direction of electron flow, the four fingers will point in the direction of electron flow, the four fingers will point in the direction of the _____.
4. Complete statements about electromagnets and coils. Insert the word(s) that best completes each of the following statements.
- a. The field of force around a conductor can be strengthened by forming the conductor into a _____.
- b. The strength of the magnetic field depends on the number of coils in the conductor and the amount of _____ applied to the conductor.
- c. The strength of the magnetic field can be made much stronger by placing an _____ core inside the coiled conductor.
- d. When electricity flows through the conductor coils, the iron core becomes an _____.
- e. The polarity of the electromagnetic field can be determined by using the left hand rule for coils:
- (1) Grasp the coil in such a way that your _____ point in the direction of current flow.
- (2) Your _____ will point to the N pole of the electromagnet.
- f. Reversing the direction of _____ in an electromagnet reverses the N and S poles of the electromagnet.
- g. Electromagnets can be turned on or off by simple controls and made to do useful _____.
- h. A metal conductor can be so constructed that when electric current flows through it, the magnetic force created will pull a metal _____ into the coil.
- i. The metal _____ moving into the coil when the coil is energized and moving out of the coil when the current is shut off is the principle that makes _____ work, and the same kind of _____ used in many major appliances.

Written Test

5. State other principles of magnetism. Write in the correct answer to each of the following questions.

a. What happens when a magnetic field cuts across the wire?

Answer _____

b. What does making a transformer require?

Answer _____

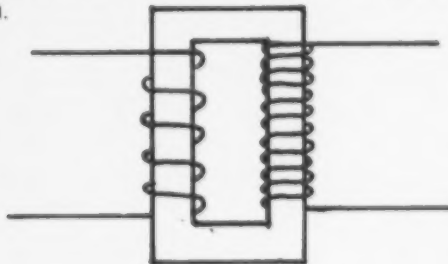
c. Electricity directly from a power source flows through the primary coil in a transformer, but what kind of electricity flows through the secondary coil in a transformer?

Answer _____

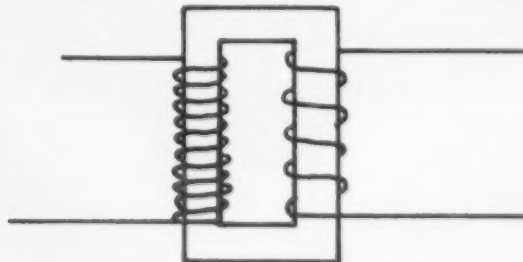
d. The primary coil receives electrical input, but what does a secondary coil in a transformer become?

Answer _____

6. Identify types of transformers. Place the correct name of the transformer type under the correct illustration.



a. _____



b. _____

Written Test

7. Complete statements about DC motor components. Insert the word(s) that best completes each of the following statements
- a. DC motors are not in common use around major appliances, but knowing how they work will help a technician better understand AC _____ motors that are used with major appliances.
 - b. The basic DC motor has four major components:
 - (1) An _____ which is an electromagnet mounted on a shaft so it can turn.
 - (2) A split-ring _____.
 - (3) _____ that the _____ makes contact with.
 - (4) A _____ field so that the armature will _____.
8. Select true statements about DC motor operation. Place an "X" beside each true statement.
- _____ a. The arrangement of the commutator and brushes causes the electricity that flows through the armature to reverse its direction each time the armature rotates half a revolution.
 - _____ b. Turning a switch to ON turns the armature into an electromagnet, and since like magnetic poles repel each other, the armature's N and S poles spin away from the N and S poles of the field magnet.
 - _____ c. Since opposite magnetic poles attract, the N and S poles of the field magnet attract the opposite poles of the armature as the armature turns.
 - _____ d. Just as the N and S armature poles align themselves with the opposite S and N poles in the field magnet, the commutator/brush arrangement reverses the flow of electricity in the armature.
 - _____ e. Since the poles on the armature are reversed electrically, the armature and field magnets repel each other once again and the armature continues to spin and produce direct current.
9. Complete statements about AC induction motors. Insert the word(s) that best completes each of the following statements.
- a. The AC induction motor is the one most frequently used with major appliances because its rugged construction is especially suited to _____ speed applications, and it has a long, trouble-free service life.

Written Test

- b. AC induction motors have several advantages over DC motors:
- (1) AC current is more readily _____.
 - (2) Induction motors have no _____ or _____ to wear out.
 - (3) Induction motors are _____ and can be used in applications where a DC motor might create a hazard.
- c. AC induction motors use a rotating magnetic field to produce torque, a field created by winding wires of different size and resistance onto _____ within a stator.
- d. The windings in an induction motor are either _____ resistance start windings or _____ resistance run windings.
- e. When an induction motor is started, a normally closed _____ switch connects both the start and run windings in parallel across the line.
- f. When the motor reaches 75% to 80% of its designed operating speed, the _____ switch opens to disconnect itself from the circuit as the motor continues to operate with only the _____ windings.
10. Match components of an AC induction motor with their functions. Place the number beside the component in the blank beside its function.
- | | | |
|----------|--|-----------------------|
| _____ a. | The outer protective covering designed for specific service application | 1. End bells |
| _____ b. | The stationary laminated iron casing containing the poles that start and run windings are wound onto to form a magnetic field | 2. Centrifugal switch |
| _____ c. | A cylinder with laminations of soft iron that rotates within the stator on a shaft that may have the centrifugal switch attached to it | 3. Motor housing |
| | | 4. Stator |
| | | 5. Assembly bolts |
| | | 5. Rotor |
| | | 7. Thermal overload |

Written Test

- ____ d. A control device that disconnects the start windings after a motor reaches 75% to 80% of its normal operating speed so the motor will continue operation on the run windings only
- ____ e. A protection device that shuts the motor off to keep it from overheating
- ____ f. The flange-like caps on each end of the motor that contain bearings which support the shaft, usually have open slots for ventilation, and one of these may contain the centrifugal switch
- ____ g. Bolts that go through the motor housing and hold the end bells in place

11. Solve problems about types of AC induction motors. Answer the following questions.

- a. Why do induction motors require starting devices?

Answer _____

- b. How are induction motors usually typed?

Answer _____

- c. What type of induction motor do present day appliances require, and why?

Answer _____

Written Test

12. Select true statements about operations of an induction start, induction run motor. Place an "X" beside each true statement.

- ☐ a. An induction start, induction run motor has an external starting mechanism.
- ☐ b. The induction start, induction run motor has a start and run winding, and when voltage is applied to the start winding, it starts the rotor turning.
- ☐ c. When the motor reaches a speed of approximately 1150 rpm, a centrifugal switch in the motor disconnects the start winding and engages the run winding.
- ☐ d. The motor continues to run on the run winding only.

13. Select true statements about capacitor start, induction run motors. Place an "X" beside each true statement.

- ☐ a. A capacitor start, induction run motor has no external starting mechanism.
- ☐ b. As the motor is energized, the line voltage decreases 20 to 25 percent, and the voltage that is stored in the capacitor is now at a higher potential than the line voltage, so the capacitor discharges an electrical surge that increases starting torque.
- ☐ c. As the motor reaches a speed of approximately 1150 rpm, a centrifugal switch disconnects the starting capacitor and engages the run winding.
- ☐ d. The motor continues to run on the run winding only as the capacitor circuit is recharged.

14. Complete statements about motor housings. Insert the word(s) that best completes each of the following statements.

- a. For some special applications such as _____ motors or certain automatic dishwashers, motors use a vapor-proof or dust-proof housing that totally encases the motor.
- b. Totally enclosed motors run _____ and generally have a shorter service life than vented motors.
- c. Totally enclosed motors generally have to be replaced when the go bad because there is _____ that can be performed on them.

Written Test

- d. The trend in modern appliance motors is to use an open-frame housing which promotes _____ operation.
 - e. Motors in open-frame housings are called _____ motors because it is not cost effective to work on them, and the open-frame housings are almost impossible to reassemble because they are welded together or glued together with epoxy.
 - f. Motors with open-frame housings are the most _____ type confronted in major appliance service, and such motors will be found on almost all major appliances designed for normal use.
 - g. Motors with open-frame housing cost less, but they do collect lint and dirt readily, and part of every service call should be to _____ the open-frame motor if the appliance has one.
 - h. Motor housings are designed for special applications and often determine the nature of motor _____.
15. Solve problems about motor speeds. Answer the following questions.
- a. If an automatic washer has a normal and a gentle cycle, will it have a single-speed, two-speed, or three-speed motor?
Answer _____
 - b. If an automatic washer has a normal, wash and wear, and a delicate cycle, will it have a single-speed, a two-speed, or a three-speed motor?
Answer _____

Written Test

16. Match types of motor bearings with their characteristics. Place the number beside the bearing type in the blank beside its characteristic.

- | | | |
|----------|---|--------------------|
| _____ a. | Commonly found in induction motors on washers because they are least expensive and have good service life, but are prone to get noisy as they wear out | 1. Roller bearings |
| _____ b. | Commonly found in induction motors on appliances where less noise is preferred and where cooler operation is desired for increased performance and motor life | 2. Ball bearings |
| _____ c. | More expensive than other types of bearings, but less friction makes for a quieter running motor that is preferred for special applications | 3. Sleeve bearings |

17. Solve problems about motor thermal protection. Answer the following questions.

- a. If a thermal overload on an AC induction motor goes bad, does the motor have to be replaced?

Answer _____.

- b. What should be done before attempting to start or troubleshoot a hot or overheated motor?

Answer _____.

18. Complete statements about other motor problems. Insert the word(s) that best completes each of the following statements.

- a. Motors function best within a 10% range above or below their rated nameplate _____.
- b. Low voltage reduces starting torque, increase full load temperature, and _____ motor life.
- c. High voltage increases starting torque, produces increased heat, and _____ motor life.
- d. Excess voltage variations up or down will increase heat, cause _____ and vibration, and shorten motor life.

Written Test

- e. Modern appliance motors have a lifetime _____ system built in, but some motors still have an oiler tube so oil can be added as required by specifications.
 - f. Never over lubricate a motor; in fact, most specification call for only two or three _____ of oil every six months.
 - g. Oiler tubes have _____ and these should always be checked to make sure they are in place so dirt will not get into the bearing directly below the tube.
 - h. Never replace a motor with a _____ motor, and never overload a motor.
 - i. Belts on motor pulleys should be properly adjusted, and the rule of thumb is that the belt under normal pressure should deflect no more than a distance equal to the _____ of the belt.
19. Select true statements about using compressor test cords in motor testing. Place an "X" beside each true statement.
- ____ a. Compressor test cords are useful for checking a motor for mechanical problems such as being locked up or having bad bearings, and these problems may exist even through the motor checks okay on all electrical tests.
 - ____ b. A bench test with a test cord is the best way to assure that the motor is sound mechanically as well as electrically, but electrical tests should always be made before test cord use to avoid blowing the fuse in the test cord.
 - ____ c. A test cord bypasses all control circuits so that the motor can be tested at normal rpm.
 - ____ d. A test cord can be used in conjunction with a wattmeter to see if the motor is drawing too much amperage.
 - ____ e. For safety, a good test cord will have 3 wire power cords and a ground cord to attach to the motor housing.
 - ____ f. Test cords are available from parts supply stores or can be assembled in a shop from readily available components.
20. Complete a list of guidelines for servicing throwaway motors. Insert the word(s) that best completes each of the following statements.
- a. A centrifugal switch on a throw-away motor is always located _____ the motor on the opposite end of the drive pulley.
 - b. The centrifugal switch can be tested for _____ with an ohmmeter, and replaced as required.

Written Test

- c. On a capacitor start, induction run motor, the capacitor can be tested for capacitance with a VOM or a _____, and replaced as required.
 - d. The thermal overload on all motors with open-frame _____ can be tested for continuity with an ohmmeter, and replaced as required.
 - e. All start windings and run windings in an induction motor are _____ and it is not cost effective to attempt to service them by rewinding.
21. Solve problems about motor nameplate information. Answer the following questions.
- a. What are at least five items of importance that will be found on a motor nameplate?
 - (1) _____
 - (2) _____
 - (3) _____
 - (4) _____
 - (5) _____
 - b. What is the safest rule to follow when ordering an entire replacement motor or a single component?
Answer _____
22. Complete statements about motor safety. Insert the word(s) that best completes each of the following statements.
- a. Always unplug a motor from its _____ before starting any electrical checks.
 - b. Always allow a hot or overheated motor to _____ before attempting to restart it or performing any tests.
 - c. When installing a motor, always make sure the _____ to the appliance chassis is securely fastened.
 - d. Roll up your sleeves or wear tight fitting cuffs when you're working around any kind of _____ equipment because loose clothing can be easily caught on a motor shaft.

Written Test

23. Arrange in order the steps in systematically troubleshooting an induction motor. Place the correct sequence number in the correct blank.

- ____ a. Check with a VOM for power at the outlet into which the motor was plugged.
- ____ b. If there is no power at the outlet, check the breaker box or fuse panel.
- ____ c. If the breaker is tripped, reset it; if a fuse is blown, replace it.
- ____ d. Make all the electrical checks you can make with your VOM.
 - (1) The capacitor on a capacitor start motor is always accessible and can be checked with a capacitor analyzer and replaced as required.
 - (2) The thermal overload on a throw-away motor can be checked with a VOM and replaced as required.
 - (3) If a centrifugal switch is located outside the motor on a throw-away motor, the switch can be checked with a VOM and replaced as required, but if the centrifugal switch is inside the motor, the motor will have to be replaced.
- ____ e. Plug the motor into the outlet again and attempt to start the motor.
- ____ f. If the motor again trips the breaker or blows a fuse, the problem is in the motor.
- ____ g. Once the problem is established as being in the motor, check for loose connections or broken wires around the motor.
- ____ h. Hook the motor up to a test cord and check it for mechanical problems such as loose bearings.
- ____ i. If electrical or mechanical checks indicate a problem that would not be cost effective to repair, replace the motor according to information on the old motor nameplate.
- ____ j. Unplug the motor from the power source.

Permission to duplicate this test is granted.

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**AC Induction Motors
Unit 4**

Answers to Written Test

1.

a.	5	i.	2
b.	9	j.	13
c.	11	k.	4
d.	1	l.	15
e.	6	m.	7
f.	8	n.	12
g.	14	o.	3
h.	16	p.	10

2.

a.	Flux
b.	Repel
c.	Attract

3.

a.	magnetic flux
b.	magnetic field

4.

a.	coil
b.	voltage
c.	iron
d.	electromagnet
e.	(1) fingers
	(2) thumb
f.	current flow
g.	work
h.	plunger
i.	plunger, solenoids, solenoids

5.

a.	It induces electricity into the wire
b.	Two iron cores wrapped with wire be placed alongside each other
c.	Induced electricity
d.	A source of electrical output

6.

a.	Step-up transformer
b.	Step-down transformer

7.

a.	induction
b.	(1) armature
	(2) commutator
	(3) Brushes, commutator
	(4) magnetic, spin

8. a, b, c, d, e

Answers to Written Test

9.
 - a. constant
 - b. (1) available
(2) commutator, brushes
(3) spark free
 - c. poles
 - d. high, low
 - e. centrifugal
 - f. centrifugal, run

10.

a.	3	e.	7
b.	4	f.	1
c.	6	g.	5
d.	2		

11.
 - a. When they start, they draw 6 to 8 time their normal running current.
 - b. According to their start/run characteristics.
 - c. Capacitor start, induction run motor because it has higher starting torque.

12. b, c, d

13. b, c, d

14.
 - a. fan
 - b. hotter
 - c. little service
 - d. cooler
 - e. throw-away
 - f. common
 - g. vacuum
 - h. service

15.
 - a. Two-speed
 - b. Three-speed

16.
 - a. 3
 - b. 1
 - c. 2

17.
 - a. No
 - b. Allow the motor to cool down

18.
 - a. voltage
 - b. shortens
 - c. shortens
 - d. noise

Answers to Written Test

- e. lubrication
 - f. drops
 - g. flip caps
 - h. smaller
 - i. width
19. a, b, c, d, e, f
20. a. outside
b. continuity
c. capacity checker
d. housings
e. internal
21. a. Any five of the following:
(1) Model number
(2) Serial number
(3) Type
(4) Horsepower
(5) Hertz
(6) Voltage
(7) Full load amperage
(8) Locked rotor amperage
(9) Service factor
(10) RPM
(11) Frame type
(12) TEMP RISE
(13) Duty rating
- b. Copy down all of the nameplate information.
22. a. power source
b. cool down
c. ground wire
d. rotating
23. a. 2 f. 6
b. 3 g. 7
c. 4 h. 9
d. 8 i. 10
e. 5 j. 1

AC Induction Motors
Unit 4

Unit Evaluation Form

Student Name _____ Date _____ Unit Rating _____

Job Sheet Ratings

Job Sheet #1—Troubleshoot an AC Induction Motor for
Thermal Overload

Rating _____

Comments: _____

Job Sheet #2—Troubleshoot an AC Induction Motor to Determine
Whether the Start Mechanism or the Start Windings Are Bad, and
Replace a Centrifugal Switch

Rating _____

Comments: _____

Job Sheet #3—Bench Test a Single-Speed Motor With a
Test Cord

Rating _____

Comments: _____

Written Test Scores

Pretest _____ Posttest _____ Other _____

Other _____

Teacher Signature _____ Date _____

Student Signature _____ Date _____

Permission to duplicate this form is granted.

**Diagrams and Schematics
Unit 5**

Unit Contents

Teacher Components

	Teacher Page
1. Suggested Activities	
a. Instructional Plan.....	1
b. Teaching Suggestions.....	2
c. Resources Used in Developing This Unit	2
d. Suggested Supplemental Resources	2
e. Instructions for Evaluating Student Performance	3
2. Answers to Assignment Sheets	5
3. Written Test.....	7
3. Answers to Written Test.....	15
4. Unit Evaluation Form	17

Student Components

1. Objective Sheet	MAR-127
2. Information Sheet	MAR-129
3. Student Supplements	
Student Supplement 1—Schematic Diagram.....	MAR-141
Student Supplement 2—Wiring Diagram	MAR-143
Student Supplement 3—Other Graphic Aids.....	MAR-145
Student Supplement 4—Wiring Harness	MAR-147
Student Supplement 5—Timer Sequence Chart and Schematic Diagram	MAR-149
4. Assignment Sheet 1—Interpret a Timer Sequence Chart and Wiring Diagram for an Automatic Washer	MAR-151

Diagrams and Schematics Unit 5

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction or individual learning activities. Study the specific objectives to determine the order in which you will present the objectives.
2. Review Teaching Suggestions section that follows. Plan for classroom activities.
3. Plan enrichment of exceptional students as well as accommodation of special needs students.
4. Add overheads or other graphic materials as desired to enhance instruction.
5. Develop teaching plan. Adjust for different learning styles.
6. Make copy of the Unit Evaluation Form for each student.

Delivery and Application

7. Provide students with unit of instruction.
8. Discuss unit and specific objectives.
9. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic skills when applicable.
10. Discuss and demonstrate activities in the job sheets. Review criteria for evaluating these activities.

Evaluation

11. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.
12. Make copies of written test. Add or modify test items as needed.
13. Give written test.
14. Compile assignment sheet ratings and written test scores on the Unit Evaluation Form.
15. Reteach and retest as required.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface in the Teaching Suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: a SCANS Report for America 2000*. These SCAN skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

1. Have available schematics taken directly from appliances so you can demonstrate what kind of graphic aids manufacturers provide with their equipment. Impress upon students the importance of looking for schematics and/or wiring diagrams to help with appliance troubleshooting. **Basic skills, science, math, and listening.**
2. Have individual students find schematics or wiring diagrams on appliances at their home or apartment. Encourage students to bring the schematics to class, if they can, or have them make notes or sketches they can use to make a brief report to the class. **Basic skills, writing and speaking. Information skills, acquisition and evaluation.**
3. Use schematics from appliances to reinforce the symbols presented in Objective 10. Use the graphic with Assignment Sheet 1 to demonstrate how a ladder schematic is used to show how components interact in an appliance. **Basic skills, science and math.**

Resources Used in Developing This Unit

1. Clemons, Mark. *ACR Electrical Systems*. Stillwater, OK 74074: The Mid-America Academic and Vocational Curriculum Consortium, 1997.
2. Vorderstrasse, Ron. *General Electronic Technician*. Stillwater, OK 74074: Mid-America Vocational Curriculum Consortium, 1988.
3. Bacon, Bill and Mack Sutton. *Major Appliance Repair*. Austin, TX 78712: The University of Texas at Austin, 1983.
4. Kaiser, Joe. *Electrical Power*. South Holland, IL: The Goodheart Willcox Company, Inc., 1982.

Suggested Supplemental Resources

Carrier's modular-based general training programs are excellent sources for students beginning their study of electricity. Illustrations in the modules are in full color and further enhanced with available VHS video materials, slide/audio programs, and cassette tapes. The following modules would serve well to supplement materials in this unit. Those modules and their Carrier ID number, are:

Electrical Components and Their Symbols GTE2-2
Wiring Diagrams GTE2-3
Wiring Diagram Exercises GTE2-4

Suggested Activities

The modules are available with a quantity discount for vo-tech schools and certain other training facilities. For information, the Carrier FAX is 315-432-3418, or write to:

Carrier
Literature Services Bldg. TR-8
P.O. Box 4808
Syracuse, NY 13221

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

- 4 Skilled—Can perform job with no additional training.
- 3 Moderately skilled—Has performed job during training program; limited additional training may be required.
- 2 Limited skill—Has performed job during training program; additional training is required to develop skill.
- 1 Unskilled—Is familiar with process, but is unable to perform job.

Option B

- Yes—Can perform job with no additional training.
- No—Is unable to perform job satisfactorily.

**Diagrams and Schematics
Unit 5**

Answers to Assignment Sheets

Assignment Sheet 1

1. At about 10 (5) minutes into the cycle at the beginning of the first wash operation, and at about 14 (7) minutes into the cycle at the beginning of the second wash operation
2. At about 38 (19) minutes into cycle at the beginning of the final rinse
3. No
4. 1B controls the fill function, and 1T controls the drain function
5. Cool dry and heat dry
6. 1A
7. It means there are two heater circuits, one to maintain water temperature and the other for drying
8. The door switch, the float switch, and the fill valve
9. 3T and 1B
10. That the circuit is complete through the timer
11. The heating element
12. Yellow with a black tracer should be traced back to timer cam 2T

**Written and Schematics
Unit 5**

Written Test

Name _____ Date _____ Score _____

1. Match each term on the right with its correct definition.

_____ a. The frame and lower covering of an appliance where the operating components and their associated wiring are housed

_____ b. The upper panel of an appliance that houses control devices such as timers and switches and is frequently lighted to enhance the appearance of the appliance

_____ c. The use of colored insulation around conductor wires to identify different circuits in an appliance, and the marking of terminals with appropriate colors to assure assembly and facilitate more efficient troubleshooting

_____ d. Diagrams, schematics, line drawings, views, and photographs available for a given product to assure proper assembly and efficient service

_____ e. A hand drawn or computer drawn pictorial as opposed to a photograph

_____ f. A view of an object from a given angle such as the top, bottom, end, or side

_____ g. A drawing or other graphic representation of an object made in such a way that it helps a viewer visualize how the object is made or how it works

_____ h. A second color of narrow width molded into the basic color of the insulation around a wire

_____ i. A portion of an object presented in a perspective which helps to clarify its assembly or its function

1. Line drawing

2. Tracer

3. Graphic aids

4. Cabinet

5. Perspective

6. Color coding

7. View

8. Console

9. Pictorial

Written Test

2. Select true statements about block diagrams. Place an "X" beside each true statement.
- ____ a. Block diagrams are simple illustrations showing the relationship of components in a circuit.
 - ____ b. Block diagrams use boxes or circles to indicate relative component location and often have the name of the component written near the box or circle.
 - ____ c. Block diagrams sometimes use switch symbols, but other symbols are seldom found on a block diagram.
 - ____ d. Block diagrams sometimes use arrows to indicate the direction of current flow.
 - ____ e. Block of diagrams are often used to illustrate in a general way how an appliance circuit and components are related, and are good for actual troubleshooting activity.
 - ____ f. Block diagrams usually have legends like wiring diagrams and schematic diagrams do.
3. Complete statements about schematic diagrams. Insert the word(s) that best completes each of the following statements.
- a. Schematic diagrams do not show _____ detail, but are used to show how a circuit is structured to serve the components in an appliance.
 - b. Schematic diagrams serve to illustrate _____ operations, but do not show actual detail of wires, terminals, and connectors.
 - c. If you know electrical _____, schematics are relatively easy to read.
 - d. The limitation of a schematic is that its lack of detail makes it difficult to use in situations where _____ by _____ troubleshooting is required.
 - e. Schematic diagrams frequently have _____ to clarify circuit structure and component relationships to the circuit and control devices.
4. Solve problems about wiring diagrams. Answer the following questions.
- a. Why are wiring diagrams a troubleshooter's best friend?
Answer _____
 - b. Why are sizes and shapes in a wiring diagram not to scale?
Answer _____

Written Test

- c. Why do wiring diagrams help make circuit troubleshooting easier?

Answer _____

5. Match other graphic aids with their functions. Place the number beside the graphic aid in the blank beside its function.

- | | | |
|----------|--|----------------------------|
| _____ a. | Use dashes to create a window to expose an object that would otherwise be hidden or to represent an object that is hidden | 1. Section views |
| _____ b. | Use irregular lines to create a window that permits a viewer to better visualize an assembly or a troubleshooting activity | 2. Wiring harness diagrams |
| _____ c. | Used to clarify other pictorials by enlarging and spotlighting parts of a component that would be otherwise difficult to visualize | 3. Detail views |
| _____ d. | Slice through the plane of an object to display internal component relationships and operations | 4. Exploded views |
| _____ e. | Depict components separated and suspended in the order in which they fit together | 5. Phantom views |
| _____ f. | Show how wires are actually connected to terminals or to other wires | 6. Cutaway views |

6. Complete statements about where to find helpful graphic aids. Insert the word(s) that best completes each of the following statements.

- a. Repair manuals, service manuals, and installation guides are usually well illustrated with schematics, diagrams, timer charts, and photographs or line drawings to depict proper assembly and _____.
- b. A wiring diagram or a schematic is usually attached to an appliance _____ a service panel so that a service technician can readily find it.
- c. Wiring diagrams or schematics should always be returned to the _____ after use so that the next technician who works on the appliance will not have to waste time finding a proper diagram.

Written Test

- d. Repair manuals, service manuals, and installation guides use cutaways, phantom lines, and detail views to help clarify difficult _____ or service routines.
 - e. Exploded views are used frequently in service literature, but are also common in parts catalogs because the detail is most effective for helping relate parts to their _____.
 - f. Wiring harness diagrams are used mostly at the point where an appliance is actually _____ in the factory, but every now and then they show up in service literature when wiring needs to be detailed.
7. Select true statements about timer sequence charts. Place an "X" beside each true statement.
- _____ a. Timer sequence charts are almost always included with an appliance that has a timer, and they frequently are shown with a wiring diagram or schematic because the two should be used together.
 - _____ b. The timer sequence chart is a valuable troubleshooting tool because it depicts what is happening at any given point in an operating cycle.
 - _____ c. Timer sequence charts number the timer switches and list the functions of each switch.
 - _____ d. Each timer switch number indicates the color code of the terminal and the wiring that connects components controlled by each of the timer switches.
 - _____ e. When used with a wiring diagram or schematic, a timer sequence chart can be used to quickly isolate a problem component or a bad switch.
8. Complete a list of what legends do. Circle the word(s) that best completes each of the following statements.
- a. Legends accompany diagrams, schematics, and other pictorials to provide a key for property **(interpreting)** **(applying)** the material.
 - b. Legends are typically used to
 - (1) Indicate **(color)** **(assembly)** code meanings.
 - (2) Indicate **(normal)** **(special)** circuitry.
 - (3) provide **(notations)** **(hints)** needed to interpret abbreviations and special symbols.

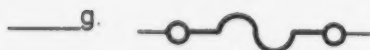
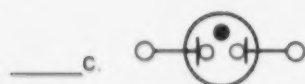
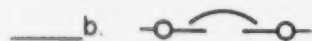
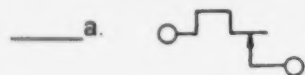
Written Test

9. Complete the following chart of common color code abbreviations. Insert the correct name in the correct blank.

B or BK = Black	B = b. _____	PU = d. _____	W = f. _____
BR = Brown	GY = Gray	R = Red	Y = Yellow
BU = a. _____	O or OR = Orange	T = e. _____	TR = g. _____
LBU = Light Blue	P or PK = c. _____	V = Violet	

Written Test

10. Identify basic electrical symbols. Match the correct term with the correct symbol.



1. Chassis ground
2. Fuse
3. Circuit breaker
4. Overload
5. Water-level switch
6. Single-speed motor
7. Light emitting diode
8. Thermostat
9. Momentary switch
10. Resistor
11. Neon light

Written Test

11. Complete statements about solid-state devices. Insert the word(s) that best completes each of the following statements.
- a. Since more and more modern appliances are using solid state devices for _____, repair technicians need to know solid state symbols.
 - b. Solid state controls usually include _____, diodes, triacs, rectifiers, and silicon controlled rectifiers.
 - c. Solid state controls may include electronic devices such as resistors and _____.
 - d. Solid state devices promise to grow in popularity because they are compact, lightweight, and operate _____ than other types of components.
12. Complete guidelines for using diagrams and schematics. Insert the word(s) that best completes each of the following statements.
- a. Check for the _____ side or ungrounded line of the power source so you'll have a logical starting point.
 - b. Trace the current flow from the source through any _____ devices to the malfunctioning component so you can identify components that you will physically have to check on the appliance.
 - c. A hot wire passing through several in-line components indicates a _____ circuit.
 - d. Look for places where a hot wire goes into a point, but two or more wires come out; this indicates a branch or _____ circuit, and each branch has to be traced individually back to the source.
 - e. When there are two or more current sources, the sources will be confined to their own circuits, but they will never be _____.
 - f. Remember two important rules for electrical troubleshooting:
 - (1) Current never _____; if current flows into a device, it must flow out again and back to the power source for the circuit.
 - (2) If the current flow divides, it must come _____ again at a point before the power source or at the power source.
 - g. Read the _____ to be certain you know what incidental symbols mean, and take all notations into consideration.
 - h. Make sure you interpret symbols correctly, and consult a reliable reference when you're _____.

Written Test

- i. Remember that schematics and diagrams show switches and control devices in the condition they are in just before appliance operation _____ and that a manual or automatic event must take place to change a switch position.

Permission to duplicate this test is granted.

**Diagrams and Schematics
Unit 5**

Answers to Written Test

1.
 - a. 4
 - b. 8
 - c. 6
 - d. 3
 - e. 1
 - f. 5
 - g. 9
 - h. 2
 - i. 7
2. a, b, c, d
3.
 - a. wiring
 - b. general
 - c. symbols
 - d. wire, wire
 - e. legends
4.
 - a. Because wiring diagrams are more complete than schematics
 - b. Because things have to fit within a limited space
 - c. Because all wiring is color coded
5.
 - a. 5
 - b. 6
 - c. 3
 - d. 1
 - e. 4
 - f. 2
6.
 - a. service
 - b. behind
 - c. appliance
 - d. assembly
 - e. part numbers
 - f. assembled
7. a, b, c, d, e
8.
 - a. Interpreting
 - b.
 - (1) Color
 - (2) Special
 - (3) Notations
9.
 - a. Blue
 - b. Green
 - c. Pink

Answers to Written Test

- d. Purple
 - e. Tan
 - f. White
 - g. Tracer
- 10.
- a. 8
 - b. 3
 - c. 11
 - d. 9
 - e. 1
 - f. 6
 - g. 2
 - h. 10
 - i. 4
 - j. 7
 - k. 5
- 11.
- a. controls
 - b. transistors
 - c. capacitors
 - d. faster
- 12.
- a. hot
 - b. control
 - c. series
 - d. parallel
 - e. joined
 - f. (1) vanishes
(2) together
 - g. legend
 - h. not sure
 - i. starts

**Diagrams and Schematics
Unit 5**

Unit Evaluation Form

Student Name _____ Date _____ Unit Rating _____

Assignment Sheet Ratings

Assignment Sheet #1—Interpret a Timer Sequence Chart
and Wiring Diagram for an Automatic Washer

Rating _____

Comments: _____

Written Test Scores

Pretest _____ Posttest _____ Other _____

Other _____

Teacher Signature _____ Date _____

Student Signature _____ Date _____

Permission to duplicate this form is granted.

Tools, Materials, and Test Instruments
Unit 6

Unit Contents

Teacher Components

	Teacher Page
1. Suggested Activities	
a. Instructional Plan.....	1
b. Teaching Suggestions.....	2
c. Resources Used in Developing This Unit	2
d. Suggested Supplemental Resources	2
e. Instructions for Evaluating Student Performance	3
2. Answers to Assignment Sheets	5
3. Written Test	7
3. Answers to Written Test.....	15
4. Answers to Written Test.....	21
5. Unit Evaluation Form	25

Student Components

1. Objective Sheet	MAR-155
2. Information Sheet	MAR-157
3. Student Supplements	
Student Supplement 1—Basic Hand Tools	MAR-179
Student Supplement 2—Other Hand Tools	MAR-181
Student Supplement 3—Measuring Voltage at a Receptacle	MAR-183
Student Supplement 4—Measuring Voltage in a Parallel Circuit	MAR-185
Student Supplement 5—Measuring Amperage in a Circuit	MAR-187
Student Supplement 6—Measuring Resistance in a Coil	MAR-189
4. Assignment Sheets	
AS 1—Identify Selected Tools.....	MAR-191
5. Job Sheets	
JS 1—Test Electrical Receptacles for Correct Voltages	MAR-193
JS 2—Use a Clamp-On Ammeter to Test for High and Low Amperages on a Fan Motor and a Light Bulb	MAR-197

Unit Contents

JS 3—Make a Continuity Check of Magnetic Control Assembly From an Automatic Washer -----	MAR-199
JS 4—Splice Electrical Conductors to Acceptable Service Standards -----	MAR-201
JS 5—Use a VOM for a Quick Capacitor Check-----	MAR-205

Tools, Materials, and Test Instruments
Unit 6

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction or individual learning activities. Study the specific objectives to determine the order in which you will present the objectives.
2. Review Teaching Suggestions section that follows. Plan for classroom activities.
3. Plan enrichment of exceptional students as well as accommodation of special needs students.
4. Add overheads or other graphic materials as desired to enhance instruction.
5. Develop teaching plan. Adjust for different learning styles.
6. Make copy of the Unit Evaluation Form for each student.

Delivery and Application

7. Provide students with unit of instruction.
8. Discuss unit and specific objectives.
9. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic skills when applicable.
10. Discuss and demonstrate activities in the assignment and job sheets. Review criteria for evaluating these activities.

Evaluation

11. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.
12. Make copies of written test. Add or modify test items as needed.
13. Give written test.
14. Compile assignment sheet ratings and written test scores on the Unit Evaluation Form. Include any additional assignment or job sheets added to the unit.
15. Reteach and retest as required.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface type in the Teaching Suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: a SCANS Report for America 2000*. These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

1. Invite a local plumber or pipefitter to demonstrate to the class how to use adjustable hand tools to best advantage. Ask them to specifically demonstrate how a pipe wrench can be used as a "backup" to help with breaking out and making up connections without tearing up pipes and lines. **Basic skills, science and listening.**
2. When talking about hand tools in the early objectives, point out specific uses for each tool and why tools are designed for specific uses. Have student handle tools as you demonstrate their uses. Examine Assignment Sheet 1 and select and number hand tools for students to identify. **Thinking skills, knowing how to learn.**
3. Demonstrate the uses of test instruments including a wattmeter, a temperature probe, and a capacitor analyzer. Prepare a demonstration to show the correct uses and variety of uses for a VOM and a clamp-on ammeter. **Basic skills, science, math, and listening.**
4. Invite a local air conditioning technician to give a demonstration of soldering. Impress upon students the requirement for wearing safety glasses when soldering. **Personal management skills, responsibility.**

Resources Used in Developing This Unit

1. Clemons, Mark. *ACR Electrical Systems*. Stillwater, OK 74074: The Mid-America Academic and Vocational Curriculum Consortium, 1997.
2. Vorderstrasse, Ron. *General Electronic Technician*. Stillwater, OK 74074: The Mid-America Vocational Curriculum Consortium, 1988.
3. Bacon, Bill and Mack Sutton. *Major Appliance Repairer*. Austin, TX 78712: The University of Texas at Austin, 1983.

Suggested Supplemental Resources

1. Evans, Alvis J. *The Multitester Guide*. Indianapolis: Prompt Publications, 1992.
2. *National Electric Code*, 1996. Quincy, MA: National Fire Prevention Association, 1995.

Suggested Activities

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

- 4 Skilled—Can perform job with no additional training.
- 3 Moderately skilled—Has performed job during training program; limited additional training may be required.
- 2 Limited skill—Has performed job during training program; additional training is required to develop skill.
- 1 Unskilled—Is familiar with process, but is unable to perform job.

Option B

- Yes—Can perform job with no additional training.
- No—Is unable to perform job satisfactorily.

Tools, Materials, and Test Instruments
Unit 6

Answers to Assignment Sheets

Assignment Sheet 1

To provide for local application, use evaluation criteria in the assignment sheet.

Tools, Materials, and Test Instruments
Unit 6

Written Test

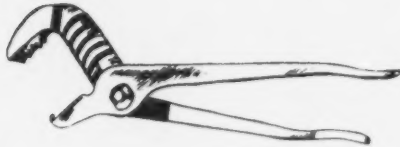
Name _____ Date _____ Score _____

1. Match each term on the right with its correct definition.

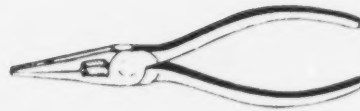
- | | | |
|----------|---|-------------------|
| _____ a. | A classification system for identifying wire conductors by diameter and number | 1. Short |
| _____ b. | A ground tied to the appliance cabinet or frame | 2. Hand tools |
| _____ c. | A conductor that serves as a return to complete an electrical circuit | 3. NEC |
| _____ d. | Frequently used portable tools that can be readily carried in a tool box | 4. AWG |
| _____ e. | Large tools, infrequently used tools, or expensive tools that would be difficult to replace | 5. Open |
| _____ f. | Guidelines dedicated to the protection of life and property in the use of electrical materials and their functions in residential and commercial applications | 6. Shop tools |
| _____ g. | A disruption in a higher resistance circuit that diverts current from its intended path into a side current of lower resistance and often blows a fuse or trips a breaker | 7. Chassis ground |
| _____ h. | A circuit through which no current flows | 8. Common |

Written Test

2. Identify the following basic hand tools. Place the correct tool name with the correct illustration.



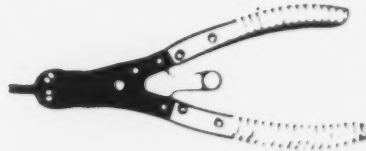
a. _____



b. _____



c. _____



d. _____



e. _____



f. _____



g. _____

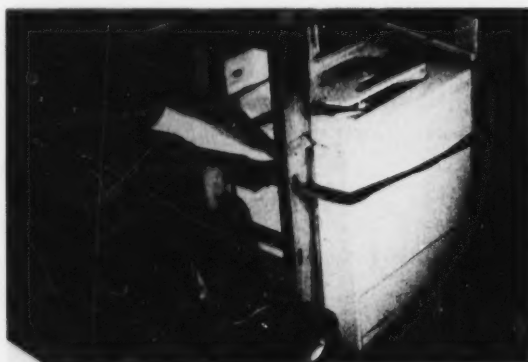


h. _____

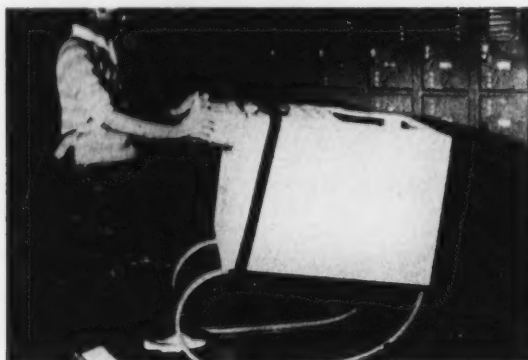
Written Test



3. Identify selected shop tools by placing the correct tool name with the appropriate illustration.

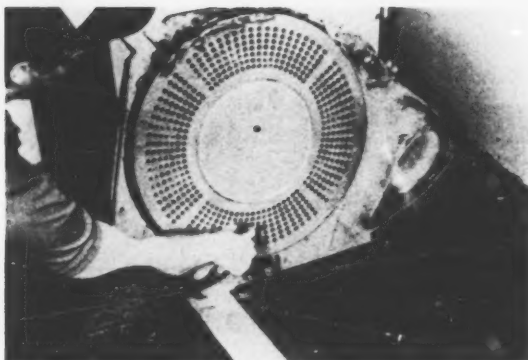


a. _____



b. _____

Written Test



c. _____

4. Complete the following list of miscellaneous supplies. Circle the word(s) that best completes each of the following statements.
- a. Electrical, masking and **(friction) (scotch)** tape
 - b. **(High) (Low)** temperature lubricant and adhesive
 - c. Rubber **(adhesive) (seals)**
 - d. Multipurpose **(cleaner) (lubricant)** such as WD-40
 - e. Degreasers and **(detergent) (etching agent)**
 - f. Leak-testing liquid and **(brush) (match)**
 - g. Lint-free shop **(towel) (rags)**
 - h. Emery cloth and **(sandpaper) (file)**
 - i. **(Shrink) (Insulated)** tubing
 - j. Assortment of nuts, bolts, screws, and **(wire) (washers)**
 - k. Assortment of wire terminals, wire nuts, and **(splicing) (connecting)** devices

Written Test

5. Match required appliance repair literature with its uses.

- | | | | |
|----------|---|----|-------------------|
| _____ a. | Relate service and repair routines to specific models of appliances | 1. | Parts catalog |
| _____ b. | Provide visual guides to electrical circuits and to component circuitry | 2. | Service manuals |
| _____ c. | Uses exploded views and numbered references for positive parts identification | 3. | Technical updates |
| _____ d. | Keep service people informed of important part changes or changes in service requirements | 4. | Schematics |

6. Solve the following problems about VOMs and their uses.

- a. How do you quickly differentiate between a short and an open by using a VOM?

Answer _____

- b. How do you zero a VOM?

Answer _____

- c. When a VOM will not properly zero, what does it usually mean?

Answer _____

7. Select true statements about clamp-on ammeters and their uses. Place an "X" beside each true statement.

- _____ a. Clamp-on ammeters are used to measure amperage in a DC current carrying conductor without having to cut into or probe the conductor itself.
- _____ b. Clamp-on ammeters can also be used to perform VOM functions with voltage and resistance with special test leads that fit into the bottoms of the meters, and scales for each function.
- _____ c. Reading resistance with a clamp-on ammeter requires inserting an in-line fuse adapter into the hot lead.

Written Test

- ____ d. A special internal fuse system eliminates the prospect that a clamp-on ammeter could accidentally be destroyed while measuring resistance.
- ____ e. Small amperages can be measured with a clamp-on ammeter by looping the conductor lead around one jaw of the clamp two, three, or four times and then dividing the reading by the number of loops.
- ____ f. Clamp-on ammeters are favored by service people because they are easy to carry, versatile, and rugged.
8. Complete statements about digital multimeters and their uses. Insert the word(s) that best completes each of the following statements.
- a. Digital multimeters do everything that VOMs can do, but have a _____ readout instead of a scale.
- b. Digital multimeters are _____ accurate than VOMs for measuring small voltages or resistances.
- c. Digital multimeters have special selectors for checking transistors in washers, dryers, and appliances that have _____ controls.
9. Select true statements about temperature testers. Place an "X" beside each true statement.

Note: For a statement to be true, all parts of the statement must be true.

- ____ a. Temperature testers are used to measure:
- (1) Ambient temperature in ovens and refrigerators
- (2) Griddle and surface temperature
- (3) Exhaust vent temperature on gas and electric dryers
- ____ b. Because temperature testers measure in millivolts converted to a Fahrenheit scale, they are less accurate than hang-in thermometers.
- ____ c. A temperature tester is remote from the sensing element and is much more convenient to use than a hang-in thermometer which requires opening the oven door to read.
- ____ d. Because of their accuracy, temperature testers are a "must" piece of equipment for recalibrating oven controls.

Written Test

10. Complete statements about capacitor analyzers and their uses. Circle the word(s) that best completes each of the following statements.
- a. Capacitor analyzers are used **(mostly)** **(strictly)** for checking capacitors on capacitor start motors on washers.
 - b. A capacitor analyzer is a much better test instrument than a VOM for determining if a capacitor is still in working condition because it will show if the capacitor is **(burned out)** **(shorted or open)**, or read the capacitor in microfarads.
 - c. A good capacitor analyzer should be able to determine power factor tolerance and general capacitance **(tolerance)** **(characteristics)**.
 - d. A good capacitor analyzer should also be able to isolate shorted capacitors and capacitors with **(overheating)** **(intermittent)** problems.
11. Select true statements about wattmeters and their uses. Place an "X" beside each true statement.
- ____ a. Wattmeters are used to measure the amount of energy consumed by a motor, an appliance, or a component.
 - ____ b. Measuring wattage will help determine if an appliance or component is drawing too much current.
 - ____ c. Conversion factors for determining watt consumption are built into wattmeters, so they're much easier to use than VOMs or clamp-on ammeters whose readings must be converted.
 - ____ d. Wattmeters can be used to measure wattages on electrical appliances in the range of 130V to 260V.
 - ____ e. Wattmeters are used for checking other meters for proper calibration.
12. Complete statements about shunts and their functions in ammeters. Insert the word(s) that best completes each of the following statements.
- a. A shunt is designed to allow only a _____ percentage of a total current to pass through an ammeter so the meter can be used to measure a wide range of currents.
 - b. Shunts eliminate the need for heavier _____ which would increase the cost and weight of ammeters and decrease sensitivity.
 - c. Shunts are built into many ammeters and are so indicated on selector scales that permit a technician to select the shunt most _____ to the measurement.

Written Test

13. Match electrical measurements with ways to make them.

- | | | |
|----------|--|---------------|
| _____ a. | Must be measured ACROSS the circuit or source being tested | 1. Amperage |
| _____ b. | Must be measured in series with the circuit being tested | 2. Resistance |
| _____ c. | Must be measured from one point to another in a component or a circuit | 3. Voltage |

14. Complete statements about appliance wiring. Circle the word(s) that best completes each of the following statements.

- a. Appliance wiring is selected according to an AWG number to identify its diameter and an insulation type to identify its **(service qualities) (relative cost)**.
- b. The AWG number grows **(larger) (smaller)** as the size of the wire increases.
- c. The major **(insulation) (AWG)** types required around major appliances are:
 - (1) RHW—Moisture and heat-resistant rubber for dry and wet locations where operating temperatures do not exceed 167°F
 - (2) THW—Moisture and heat-resistant thermoplastic for dry and wet locations where operating temperatures do not exceed 194°F
 - (3) AA—A special wire for electric ranges because it has a braided asbestos covering and can operate at temperatures up to 392°F
- d. When reading wire sizes, the **(first) (second)** number is the AWG size and the **(first) (second)** number indicates how many conductors are in the wire.
- e. The maximum amperage a wire can safely carry is known as ampacity, and low ampacity wires should **(be used carefully) (never be used)** for high ampacity applications.
- f. Never replace an AWG wire with a **(smaller) (larger)** wire because it could cause a malfunction and create a fire hazard.

15. Solve the following problems about soldering tools.

- a. A pencil soldering iron is recommended for use on printed circuit boards, but where else is a pencil iron a useful tool?

Answer _____

Written Test

- b. Soldering poses burn hazards, but what is the greater danger that soldering poses and what should be done to avoid the danger?

Answer _____

16. Complete statements about resin-core solder and its characteristics. Circle the word(s) or figure(s) that best completes each of the following statements.

- a. The type of solder used most often around electrical connections is **(40/60)** **(60/40)** resin-core solder.
- b. The 40/60 means the solder is an alloy of **(60%)** **(40%)** tin and **(60%)** **(40%)** lead.
- c. The flux required to clean metal and promote fusion is placed **(inside)** **(outside)** the core of resin-cored solder.
- d. Resin-core solder comes in handy **(cartons)** **(rolls)** that are convenient to store and carry.
- e. Resin-core solder is **(noncorrosive)** **(nontoxic)** and suitable for almost all work around major appliances.
- f. When using resin-core solder, clean surface(s) to be soldered, apply **(heat)** **(flux)** to the surfaces, and then run the strand of solder over the heated surface(s).

17. Arrange in order the procedure for using solid wire solder. Place the correct sequence number in the correct blank.

- _____ a. Apply heat to the parts to be soldered, not to the solder itself.
- _____ b. Apply the solder to the heated parts and allow it to melt onto the parts.
- _____ c. Clean surfaces to be soldered.
- _____ d. Apply soldering flux to both surfaces.

18. Arrange in order the steps in wire stripping. Place the correct sequence number in the correct blank.

- _____ a. Place the wire in the proper slot in the wire stripper and work the stripper back and forth until a cut is made around the entire insulation.
- _____ b. Hold the wire tight with one hand and use the other hand to gently move the insulation back and forth until the cut breaks clean and unwanted insulation can be pulled off.
- _____ c. Taper the insulation with a knife to increase the wire's flexibility because straight cut insulation creates a force point that can cause a wire to break.

Written Test

19. Identify the following types of splices. Place the correct name of the splice below its illustration.



a. _____



b. _____



c. _____



d. _____

20. Complete statements about guidelines for connections at screw terminals. Circle the word(s) that best completes each of the following statements.

- a. Wire should be attached at a screw terminal so that the loop lies in the (direction) (opposite direction) the screw turns.

Written Test

- b. Wire should loop the screw a little less than **(one full turn) (two full turns)**, but excessive loops are not recommended.
21. Complete statements about guidelines for good soldered splices. Insert the word(s) that best completes each of the following statements.
- a. Wires to be spliced must be bright and _____ at the point of connection.
 - b. Connecting points must be _____ so solder will solidify without wire movement.
 - c. Wire should be coated with electric soldering paste, and then soldered so that solder melts and flows into every _____ of the splice.
 - d. Entire splice area should be covered with water-proof _____.
22. Complete statements about guidelines for using solderless connectors and terminals. Insert the word(s) that best completes each of the following statements.
- a. Solderless connectors should be used according to their _____, and a connector for a lighter gauge should never be used on a wire of a heavier gauge.
 - b. Screw-on connectors work well on _____ splices, and they require no taping because they're made of insulating materials.
 - c. Crimp-on terminal lugs should not leave a _____ between the insulation and the lug, and if there is a _____, a plastic sleeve should be added to cover the bare wire.
23. Complete statements about proper care and use of hand tools. Insert the word(s) that best completes each of the following statements.
- a. Screwdrivers
 - (1) Do not hammer or _____ with screwdrivers.
 - (2) Worn Phillips screwdrivers should be _____, but flat blade screwdrivers can be useful as long as the tip can be reground _____.
 - b. Wrenches and pliers
 - (1) Do not _____ on wrenches or _____ with wrenches.
 - (2) Use adjustable wrenches so that the large jaw is _____ the direction of force.

Written Test

- (3) When pulling on an adjustable wrench, be careful not to hit yourself in the chest or head, and when pushing on an adjustable wrench, hold your hand _____ on the handle so you won't accidentally scar your knuckles.
- (4) Do not use pliers in place of a wrench, especially on _____ fittings.
- (5) Use pliers with _____ handles when working around electrical circuits and components.

c. Hammers

- (1) Never use a hammer with a _____ handle.
- (2) Use all hammers for their _____ purpose.

d. Punches, chisels, and files

- (1) Keep chisel cutting edges _____.
- (2) Keep chisel heads properly dressed, and never strike a chisel that has a _____ head.
- (3) Files become dull if stacked in a drawer, so _____ them up.
- (4) Do not hammer or pry with a file because they are _____ and break easily.

e. Socket sets and nut drivers

- (1) Do not use a _____ to gain greater leverage on the handle of a ratchet because it will strip the ratchet gears.
- (2) Do not use a _____ on a thin wall socket because the socket will break.
- (3) Nut drivers should be used for _____ nuts, bolts, and screws, but do not use pliers to increase leverage.

24. Complete a list of guidelines for using other tools and equipment. Insert the word(s) that best completes each of the following statements.

- a. Cords for drop lights should not be run over by appliance _____ or placed where objects with metal edges may be placed on them.
- b. Handle levels with care because once they're _____ they're usually inaccurate.

172

Written Test

- c. Do not apply too much pressure on a _____ key wrench or it may break or round out the socket in the set screw.
 - d. Never use _____ equipment without proper instruction or without permission.
 - e. Keep _____ in a case when they're not in use so they'll stay clean.
 - f. Never point a _____ at another person, and never use _____ when it might spray dirt or metal particles at someone nearby.
25. Select true statements about eye protection. Place an "X" beside each true statement.
- ____ a. Wear safety glasses at all times in the shop area.
 - ____ b. Blow compressed air away from you when using it for cleaning.
 - ____ c. Wear safety glasses when working with grinding tools.
 - ____ d. If you get cleaning solvent on your hands, wash them with soap and water to avoid the possibility of accidentally rubbing your eyes.
 - ____ e. Know the location of the nearest eye flush station.

Permission to duplicate this test is granted.

Tools, Materials, and Test Instruments
Unit 6

Answers to Written Test

1. a. 4 e. 6
 b. 7 f. 3
 c. 8 g. 1
 d. 2 h. 5

2. a. Adjustable pliers
 b. Needlenose pliers
 c. Locking pliers
 d. Internal snap-ring pliers
 e. Aviation snips
 f. Open end wrenches
 g. Adjustable wrench
 h. Pipe wrench
 i. Chisel
 j. Hex wrenches

3. a. Dolly
 b. Appliance flipper
 c. Compressed air supply

4. a. friction
 b. High
 c. adhesive
 d. lubricant
 e. detergent
 f. brush
 g. towels
 h. sandpaper
 i. Shrink
 j. washers
 k. connecting

5. a. 2
 b. 4
 c. 1
 d. 3

6. a. A short always shows some reading, and an open shows no reading at all.
 b. Cross the test leads and zero the ohms control knob.
 c. The battery is probably bad.

7. b, c, d, e, f

8. a. numbered
 b. more
 c. Solid-state

174

Answers to Written Test

9. a, c, d
10. a. strictly
b. shorted or open
c. tolerance
d. intermittent
11. a, b, c, d, e
12. a. small
b. coils
c. suitable
13. a. 3
b. 1
c. 2
14. a. service qualities
b. smaller
c. insulation
d. first, second
e. never be used
f. smaller
15. a. When space will not permit use of a larger iron
b. Eye damage, so always wear safety glasses when soldering
16. a. 40/60
b. 40%, 60%
c. inside
d. rolls
e. noncorrosive
f. heat
17. a. 3
b. 4
c. 1
d. 2
18. a. 1
b. 2
c. 3
19. a. Simple splice
b. Simple tap
c. Pigtail splice
d. Hook splice

Answers to Written Test

20. a. direction
b. one full turn
21. a. clean
b. tight
c. crevice
d. plastic tape
22. a. color codes
b. pigtail
c. gap, gap
23. a. (1) pry
(2) discarded, square
b. (1) hammer, hammer
(2) opposite
(3) palm-flat
(4) brass
(5) insulated
c. (1) loose
(2) intended
d. (1) sharp
(2) mushroomed
(3) hang
(4) brittle
e. (1) cheater bar
(2) cheater bar
(3) hand-tight
24. a. dollies
b. dropped
c. hex
d. oxyacetylene
e. safety glasses
f. compressed air nozzle, compressed air
25. a, b, d, e

Tools, Materials, and Test Instruments
Unit 6

Unit Evaluation Form

Student Name _____ Date _____ Unit Rating _____

Job Sheet Ratings

Job Sheet 1—Test Electrical Receptacles for Correct Voltage Rating _____

Comments: _____

Job Sheet 2—Use a Clamp-On Ammeter to Test for High and Low
Amperages on a Fan Motor and a Light Bulb Rating _____

Comments: _____

Job Sheet 3—Make a Continuity Check of a Magnetic Control
Assembly From an Automatic Washer Rating _____

Comments: _____

Job Sheet 4—Splice Electrical Conductors to Acceptable Service
Standards Rating _____

Comments: _____

177

Unit Evaluation Form

Job Sheet 5—Use a VOM for a Quick Capacitor Check

Rating _____

Comments: _____

Written Test Scores

Pretest _____

Posttest _____

Other _____

Other _____

Teacher Signature _____ Date _____

Student Signature _____ Date _____

Permission to duplicate this form is granted.

178

Automatic Washers
Unit 7

Unit Contents

Teacher Components

	Teacher Page
1. Suggested Activities	
a. Instructional Plan.....	1
b. Teaching Suggestions.....	2
c. Resources Used in Developing This Unit	3
d. Suggested Supplemental Resources	3
e. Instructions for Evaluating Student Performance	4
2. Written Test	5
3. Answers to Written Test.....	15
4. Unit Evaluation Form	19

Student Components

1. Objective Sheet	MAR-207
2. Information Sheet	MAR-209
3. Job Sheets	
JS 1—Install an Automatic Washer	MAR-219
JS 2—Troubleshoot a Whirlpool/Kenmore Automatic Washer for Typical Malfunctions	MAR-223
JS 3—Troubleshoot a GE/Hotpoint Automatic Washer for Typical Malfunctions	MAR-249
JS 4—Troubleshoot a Microprocessor Control Panel for Typical Malfunctions	MAR-265

Automatic Washers Unit 7

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction or individual learning activities. Study the specific objectives to determine the order in which you will present the objectives.
2. Review Teaching Suggestions section that follows. Plan for classroom activities.
3. Plan enrichment of exceptional students as well as accommodation of special needs students.
4. Add overheads or other graphic materials as desired to enhance instruction.
5. Develop teaching plan. Adjust for different learning styles.
6. Make copy of the Unit Evaluation Form for each student.

Delivery and Application

7. Provide students with unit of instruction.
8. Discuss unit and specific objectives.
9. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic skills when applicable.
10. Discuss and demonstrate activities in the job sheets. Review criteria for evaluating these activities.

Evaluation

11. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.
12. Make copies of written test. Add or modify test items as needed.
13. Give written test.
14. Compile job sheet ratings and written test scores on the Unit Evaluation Form. Include any additional assignment or job sheets added to the unit.
15. Reteach and retest as required.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface type in the Teaching Suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: a SCANS Report for America 2000*. These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

1. Procedures presented in many of the objectives in this unit are the foundation of good troubleshooting skills. Impress upon students the importance of troubleshooting skills in customer relations. **Basic skills, listening; Interpersonal skills, customer service.**
2. Review the job sheets carefully. Job Sheets 2 and 3 are very long and have been purposely presented in numbered routines so the job sheets can be accomplished as student time and ability permits. Once again, impress upon students the concept that good repairs translate into good customer relations. Point out the Repair Log and talk about the need for keeping good repair records as a part of good customer relations. **Thinking skills, knowing how to learn; Interpersonal skills, customer relations.**
3. Demonstrate the procedures in Job Sheet 4. Many automatic washers have microprocessor-based control panels that are programmed on a touchpad by a user. Make it clear that these boards usually have to be replaced as a unit, but show how good troubleshooting can isolate transformer problems that can be corrected. **Basic skills, science, math, and listening.**

Resources Used in Developing This Unit

1. Anderson, Edwin P. *Home Appliance Servicing*. Indianapolis, IN 46268: Howard W. Sams & Co., 1979.
2. *Repair Manual for General Electric Automatic Washers*. Garden Grove, CA 92642: Master Publications, a Gem Products, Inc. Company, 1985.
3. *Repair Manual for Your Whirlpool Automatic Washer (Belt Driven)*. Benton Harbor, MI 49022: Whirlpool Corporation, 1984.
4. *Tech-Talk "M" Clothes Washers*. Dayton, OH 45449: Frigidaire Parts and Service Company, 1983.

Suggested Activities

Suggested Supplemental Resources

1. Duarte, Lawrence A. *The Microcontroller Beginner's Handbook*. Indianapolis, IN: Prompt Publications, 1996.
2. For Frigidaire washers, service literature is available from:

Frigidaire Company
6000 Perimeter Drive
Dublin, OH 43017
1-614-764-8640
3. For GE washers, service literature is available from:

Dri-View Mfg. Co.
4706 Altmont Ave.
Louisville, KY 40209
or from the GE Parts Dept. 1-800-626-2002
4. For Maytag and Norge washers, service literature is available from:

Maytag Customer Service
Maytag Appliances
240 Edwards Street, S. E.
Cleveland, TN 37311
1-423-478-6788
5. For Whirlpool and KitchenAid washers, customer catalogs and service literature are available from:

Whirlpool Corporation
Literature Department
1900 Whirlpool Drive
LaPorte, In 46350-2585
1-800-851-4605

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Suggested Activities

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

- 4 Skilled—Can perform job with no additional training.
- 3 Moderately skilled—Has performed job during training program; limited additional training may be required.
- 2 Limited skill—Has performed job during training program; additional training is required to develop skill.
- 1 Unskilled—Is familiar with process, but is unable to perform job.

Option B

- Yes—Can perform job with no additional training.
- No—Is unable to perform job satisfactorily.

**Automatic Washers
Unit 7**

Written Test

Name _____ Date _____ Score _____

1. Match each term on the right with its correct definition.

- | | | |
|----------|---|-------------------------------|
| _____ a. | An appliance designed to clean dirty clothes in a wash, rinse, and spin-dry sequence controlled by a timer | 1. Centrifugal |
| _____ b. | The force that impels something outward from a rotating center | 2. Cycle |
| _____ c. | One complete performance of a series of events that completes a procedure | 3. Reciprocating |
| _____ d. | A timer that consists of a motorized dial and cam that makes electrical connections in a timed sequence following a manual start | 4. Automatic washer |
| _____ e. | The highly-polished look of hydrocarbon build-up resulting from heat produced by friction between brake shoes and their metal housings | 5. Glazing |
| _____ f. | A timer that uses a printed circuit board to make electronic connections in a timed sequence following user programming with a touchpad | 6. Electronic timer |
| _____ g. | Moving back and forth in an alternating motion | 7. Microprocessor-based timer |

Written Test

2. Match major components with their functions in an automatic washer. Place the number beside the component in the blank beside its function.

- | | | |
|---------|---|--|
| _____a. | An electromechanical or micro-processor-based device started manually or programmed to control the sequence of operations of an automatic washer | 1. Water pump |
| _____b. | Drives or turns the transmission or power train to provide power for agitation and spin motion | 2. Transmission |
| _____c. | Converts motor power into directional control of agitate and spin functions including reciprocating back and forth motion for agitation | 3. Motor |
| _____d. | Pumps water from the tub and may also recirculate the water in the tub by pulling it from the bottom of the tub and dumping it back in at the top | 4. Water pressure/
water level switch |
| _____e. | Controls the water level in the tub | 5. Timer |

3. Arrange in order the steps in a typical automatic washer cycle. Place the correct sequence number in the correct blank.

- _____a. Second fill
- _____b. Rinse agitation
- _____c. Final pumpout and spin
- _____d. First fill
- _____e. Wash agitation
- _____f. First pumpout and spin

4. Complete statements about fill functions in a normal cycle. Insert the word(s) that best completes each of the following statements.

- a. Machine usually fills _____ during one cycle.
- b. The first fill is a _____ fill with hot, warm, or cold water selected manually or predetermined by timer setting.

Written Test

- c. The second fill is a _____ fill with warm or cold water only (no hot water) determined by timer setting.
 - d. Timer is usually set to automatically direct cold water to the tub during the _____ fill portion of the cycle.
5. Complete statements about agitation functions in a normal cycle. Insert the word(s) that best completes each of the following statements.
- a. Machine usually agitates _____ during one cycle.
 - b. Agitation may be accomplished with reciprocating motion or by _____ a drum.
 - c. The first agitation is a _____ agitation which may vary from 6 to 18 minutes and is usually accomplished with a high-speed motor setting.
 - d. The second agitation is a _____ agitation which may vary from 2 to 6 minutes and is usually accomplished with a high-speed motor setting.
 - e. The _____ agitation mixes detergent with water and creates action to dislodge and separate soil from clothes.
 - f. The _____ agitation separates detergent residue and dislodges separated particles so that they will be removed with pumpout and not settle back onto the clothes.
6. Complete statements about pumpout and spin functions in a normal cycle. Insert the word(s) that best completes each of the following statements.
- a. Machine usually pumps out and spins _____ in one cycle.
 - b. Pumpout is initiated by the _____ and regulated by either the water level or water pressure switch.
 - c. In most washers, the water pressure switch will not allow the _____ to advance until the water has been pumped out to assure that the first spin will last 2 to 4 minutes.
 - d. The spin action creates a centrifugal force which literally _____ water from the clothes.
 - e. The final spin usually lasts at least 4 minutes or longer and is always a high speed _____ function.
 - f. On some machines, _____ rinse is an added feature of the spin function so that any residue that collects on the clothes during the spin function will be rinsed off and pumped out.

Written Test

7. Select true statements about guidelines for evaluating automatic washer malfunctions. Place an "X" beside each true statement.

- ☐ a. Identify the washer model number only.
- ☐ b. Ask the customer to explain what the machine is not doing or what the machine is doing wrong.
- ☐ c. Take notes as required so you will remember what has been said if the customer should have to leave.
- ☐ d. Verify the problem with a physical inspection or run the washer in an attempt to duplicate the problem if running the washer is still practical.

8. Arrange in order the steps for validating repairs. Place the correct sequence number in the correct blank.

- ☐ a. Double check for leaks.
- ☐ b. Check the machine for level.
- ☐ c. Make sure the washer:
 - (1) fills properly,
 - (2) agitates effectively,
 - (3) pumps out and spins properly, and
 - (4) shuts itself off.
- ☐ d. Run the washer through one full normal cycle.
- ☐ e. Do not manually advance the timer.

9. Complete statements about troubleshooting a washer that will not fill with water. Insert the word(s) that best completes each of the following statements.

- a. Check the obvious first:
 - (1) Washer may not be properly _____.
 - (2) Hoses may be _____.
 - (3) Screens in the fill hoses may be _____.

Written Test

- b. Make sure a proper _____ supply is available to the machine.
 - c. Check for proper _____ at the mixing valve with a VOM.
 - d. When a mixing valve is energized but still won't admit water, check for _____ in the valve and remove them.
 - e. Run a continuity check on the _____ switch and replace as required.
 - f. Check the _____ selection switch.
 - g. Make sure it is not a _____ problem.
 - h. Check the _____ switch to make sure it is making proper contact.
10. Select true statements about troubleshooting a washer for improper water level or water temperature. Place an "X" beside each true statement.
- ____ a. Check for reversed hot and cold water hoses.
 - ____ b. Check for the quality of the hot water supply.
 - ____ c. Check for a faulty water level switch.
 - ____ d. Check for a faulty thermal element in the mixing valve if it is a thermal type mixing valve.
 - ____ e. Check for a faulty temperature selection switch in the control panel or timer.
 - ____ f. Check for faulty timer.
 - ____ g. If the washer has a spray rinse in the spin portion of the rinse cycle, and this doesn't work:
 - (1) check for no cold water supply or a kinked cold water hose.
 - (2) check for a clogged inlet screen.
 - (3) check for a defective cold water solenoid in the mixing valve.
 - (4) check for a defective lid switch.

Written Test

11. Select true statements about troubleshooting a washer when water will not shut off. Place an "X" beside each true statement.
- ____ a. On time-fill washers, the failure of water to shut off may indicate a lid switch malfunction.
 - ____ b. Check the lid switch and replace it if it is defective.
 - ____ c. Check for foreign particles in the timer, and if present, take the timer apart and repair it.
 - ____ d. On pressure-filled models check for a bad transmission.
12. Complete statements about troubleshooting a washer that leaks water. Insert the word(s) that best completes each of the following statements.
- a. Check for loose or cracked supply _____ and tighten or replace as required.
 - b. Check for a loose _____ hose and tighten or replace the clamp as required.
 - c. Run the washer through a normal cycle and replace any _____ that is broken or appears to be damaged.
 - d. Check for worn or damaged supply hose _____.
 - e. Check for leaky gaskets:
 - (1) around the _____ pump,
 - (2) where the transmission enters the _____ tub,
 - (3) _____ between the inner and outer tub, and
 - (4) outer tub _____.
 - f. Check for cracked housing:
 - (1) outer tub, especially tubs made of _____,
 - (2) water pump _____, and
 - (3) mixing valve _____.
 - g. Replace any component with _____ housing.

Written Test

13. Complete statements about troubleshooting when water will not drain from the washer. Insert the word(s) that best completes each of the following statements.
- a. Check for a kinked or clogged _____ hose and correct as required.
 - b. Check for a water _____ problem, and readjust the _____ and tighten the _____ drive.
 - c. Check for a loose _____ at the water pump and adjust as required.
 - d. Check for a faulty transfer or _____ valve and replace as required.
 - e. Check for a defective _____ and replace as required.
 - f. Check for a faulty _____ and replace as required.
14. Select true statements about troubleshooting a washer with a motor that will not run. Place an "X" beside each true statement.
- ____ a. Make sure there is power to the machine.
 - ____ b. Check for a faulty door/lid switch and replace as required.
 - ____ c. Check for an overload device or other protective device in the circuit and replace as required.
 - ____ d. Check for a faulty timer and replace as required.
 - ____ e. Check for a faulty motor and replace as required.
15. Complete statements concerning troubleshooting a washer that will not agitate. Insert the word(s) that best completes each of the following statements.
- a. Check for a _____ malfunction and replace as required.
 - b. Check _____ for bad contacts and correct or replace as required.
 - c. Check for a faulty _____ and repair or replace as required.
 - d. Check for broken _____ or other agitation control mechanism.
 - e. Check for a broken _____ in circuitry and splice, tin, and insulate as required.
 - f. Check for stripped _____ in the agitator.

Written Test

16. Complete statements about troubleshooting a washer that will not spin. Insert the word(s) that best completes each of the following statements.
- a. If the washer will agitate but not spin, the motor is probably _____.
 - b. Check _____ for defective contacts and replace as required.
 - c. Check the _____ or _____ switch and replace as required.
 - d. Check for a faulty _____ and repair or replace as required.
 - e. Check for broken _____ or other spin control mechanisms.
 - f. Check for a faulty _____ level switch and replace as required.
 - g. Check for a broken _____ in circuitry and splice, tin, and insulate as required.
17. Select true statements about troubleshooting a washer that will not advance or shut off. Place an "X" beside each true statement.
- ____ a. If the timer will not advance, check the lid switch.
 - ____ b. Check for a defective timer and replace the timer if required or replace the timer motor if that is the problem.
 - ____ c. Replace the timer motor with a motor similar to the one removed.
 - ____ d. Check for a break in the circuitry wiring and splice, tin, and insulate as required.
18. Select true statements about troubleshooting a washer that leaks oil. Place an "X" beside each true statement.
- ____ a. If oil leaks on the floor, check for a leak in the gearcase caused by a faulty gasket, damage to the gearcase housing, or a bad transmission seal.
 - ____ b. If oil leaks onto clothes in the tub, check for a faulty gearcase or transmission seal and replace seal or transmission as required.
19. Select true statements about troubleshooting a washer that tears clothing. Place an "X" beside each true statement.

Note: For a statement to be true, all parts of the statement must be true.

Written Test

- ____ a. Caution the user to use bleach wisely;
 - (1) do not use too much bleach.
 - (2) do not add bleach at the wrong time.
 - (3) add bleach to water after loading clothes in the tub, or dilute bleach with water after putting it in the tub.
- ____ b. Check for a broken agitator and replace if required because chips and cracks in the agitator can tear clothes.
- ____ c. Check for a defective inner tub or basket and replace as required.

20. Match other washer problems with ways to correct them. Place the number beside the problem beside the way to correct the problem.

- | | |
|--|--|
| ____ a. Adjust belt to clutch or replace clutch if it is faulty | 1. Faulty water level switch |
| ____ b. Clean out clogged water pump | 2. Defective pump drive |
| ____ c. Tighten as needed or replace the coupling | 3. Washer vibrates excessively |
| ____ d. Clean out or replace valve, or replace solenoid as required | 4. Machine spins slowly |
| ____ e. Replace timer motor, or replace entire timer as required | 5. Timer will not advance to next cycle |
| ____ f. Check for obstructions and free the shaft or replace the timer as required | 6. Water does not recirculate during agitation |
| ____ g. Replace the control | 7. Tub vibrates excessively |
| ____ h. Reinforce weak floor or move washer, check for level, caution user not to overload or create unbalanced loads, or replace rubber cups on leveling feet | 8. Frozen timer shaft or knob |
| ____ i. Check for a damaged snubber and replace as required, or adjust or replace suspension bolts | 9. Defective distribution valve |

Permission to duplicate this test is granted.

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Automatic Washers
Unit 7

Answers to Written Test

1. a. 4 e. 5
b. 1 f. 7
c. 2 g. 3
d. 6
2. a. 5
b. 3
c. 2
d. 1
e. 4
3. a. 4 d. 1
b. 5 e. 2
c. 6 f. 3
4. a. twice
b. wash
c. rinse
d. rinse
5. a. twice
b. rotating
c. wash
d. rinse
e. wash
f. rinse
6. a. twice
b. timer
c. timer
d. throws
e. motor
f. spray
7. b, c, d
8. a. 4
b. 5
c. 3
d. 1
e. 2
9. a. (1) turned on
(2) kinked
(3) clogged

Answers to Written Test

- b. water
 - c. voltage
 - d. obstructions
 - e. fill
 - f. temperature
 - g. timer
 - h. lid
10. a, b, c, d, e, f
11. None of these statements are true
- 12.
- a. hoses
 - b. drain
 - c. hose
 - d. washers
 - e.
 - (1) water
 - (2) outer
 - (3) seals
 - (4) gasket
 - f.
 - (1) plastic
 - (2) housing
 - (3) housing
 - g. cracked
- 13.
- a. drain
 - b. pump, pump, pump
 - c. belt
 - d. solenoid
 - e. water pump
 - f. timer
14. a, b, c, d, e
- 15.
- a. motor
 - b. timer
 - c. transmission
 - d. linkage
 - e. wire
 - f. splines
- 16.
- a. okay
 - b. timer
 - c. door, lid
 - d. transmission
 - e. linkage
 - f. water
 - g. wire

Answers to Written Test

17. b, d

18. a, b

19. b, c

20.	a.	4	f.	8
	b.	6	g.	1
	c.	2	h.	3
	d.	9	i.	7
	e.	5		

**Automatic Washers
Unit 7**

Unit Evaluation Form

Student Name _____ Date _____ Unit Rating _____

Job Sheet Ratings

Job Sheet 1—Install an Automatic Washer Rating _____

Comments: _____

Job Sheet 2—Troubleshoot a Whirlpool/Kenmore Automatic Washer
for Typical Malfunctions Rating _____

Comments: _____

Job Sheet 3—Troubleshoot a GE/Hotpoint Automatic Washer
for Typical Malfunctions Rating _____

Comments: _____

Job Sheet 4—Troubleshoot a Microprocessor Control Panel
for Typical Malfunctions Rating _____

Comments: _____

Written Test Scores

Pretest _____ Posttest _____ Other _____

Other _____

Teacher Signature _____ Date _____

Student Signature _____ Date _____

Permission to duplicate this form is granted.

196

**Automatic Dryers
Unit 8**

Unit Contents

Teacher Components

	Teacher Page
1. Suggested Activities	
a. Instructional Plan.....	1
b. Teaching Suggestions.....	2
c. Resources Used in Developing This Unit	2
d. Suggested Supplemental Resources	2
e. Instructions for Evaluating Student Performance	3
2. Written Test	5
3. Answers to Written Test.....	13
4. Unit Evaluation Form	15

Student Components

1. Objective Sheet	MAR-271
2. Information Sheet	MAR-273
3. Job Sheets	
JS 1—Install an Automatic Dryer	MAR-281
JS 2—Troubleshoot a Whirlpool/Kenmore Automatic Dryer for Typical Malfunctions	MAR-285
JS 3—Troubleshoot a GE/Hotpoint Automatic Dryer for Typical Malfunctions	MAR-303
JS 4—Troubleshoot a Microprocessor Control Board for Typical Malfunctions	MAR-313

Automatic Dryers Unit 8

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction.
2. Review Teaching Suggestions. Plan for classroom activities.
3. Plan for students with special needs.
4. Obtain films, videotapes, and other resources to supplement instruction of this unit. See Resources and Suggested Supplemental Resources for more information.
5. Develop teaching plan. Adjust for different learning styles.
6. Review Instructions for Evaluating Student Performance.
7. Make copies of the Unit Evaluation Form, one for each student.

Delivery and Application

8. Provide students with unit of instruction.
9. Discuss unit and specific objectives.
10. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
11. Discuss and demonstrate the job sheets. Make sure all required tools, equipment, and supplies are available. Review criteria for evaluation of these activities.

Evaluation

12. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.
13. Make copies of the written test. Add or modify test items as needed.
14. Give written test.
15. Compile job sheet ratings and written test scores on the Unit Evaluation Forms. Include any additional assignments or supplemental activities that should be part of the unit evaluation.

Suggested Activities

Teaching Suggestions

1. Invite a service technician to talk to the class about troubleshooting and repairing gas dryers and the importance of safety when working with a gas dryer. **Basic skills, listening; personal management skills, responsibility.**
2. Demonstrate to the class how to install a restring kit properly so that hot spots will be eliminated. **Basic skills, listening and science.**
3. Invite an electronics instructor to talk to the class about microprocessors and chips that are part of the digital control panels on some automatic dryers, how static electricity can damage these devices, and how they can be handled safely. **Basic skills, science.**

Resources Used in Developing This Unit

1. *Do-It-Yourself Repair Manual for Your Whirlpool Gas/Electric Dryer.* Benton Harbor, MI: Whirlpool Corporation, 1983.
2. *Repair Master for Norge Gas & Electric Dryers,* Santa Monica, CA: Master Publications, Inc., 1980.
3. *Repair Master for Hamilton Gas & Electric Dryers,* Santa Monica, CA: Master Publications, Inc., 1980.
4. *Repair Master for General Electric Gas & Electric Dryers,* Santa Monica, CA: Master Publications, Inc., 1980.
5. *Service Manual for Maytag Stacked Laundry.* Cleveland, TN: Maytag Customer Service, 1993.

Suggested Supplemental Resources

1. Duarte, Lawrence A. *The Microcontroller Beginner's Handbook.* Indianapolis: Prompt Publications, 1996.
2. Service literature for Frigidaire dryers is available from:

Frigidaire Company
6000 Perimeter Drive
Dublin, OH 43017
1-614-764-8640

3. Service literature for GE dryers is available from:

Dri-View Mfg. Co.
4706 Allmond Ave.
Louisville, KY 40209

or from the GE Parts Dept., 1-800-626-2002

199

Suggested Activities

4. Service literature price lists for Maytag and Norge dryers are available from:

Maytag Customer Service
Maytag Appliances
240 Edwards Street, S.E.
Cleveland, TN 37311
1-423-478-6788

5. Consumer services literature catalogs and service literature price lists for Whirlpool and KitchenAid dryers are available from:

Whirlpool Corporation
Literature Department
1900 Whirlpool Dr.
LaPorte, IN 46350-2585
1-800-851-4605

Instruction for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

- 4 Skilled—Can perform job with no additional training.
- 3 Moderately skilled—Has performed job during training program; limited additional training may be required.
- 2 Limited skill—Has performed job during training program; additional training is required to develop skill.
- 1 Unskilled—is familiar with process, but is unable to perform job.

Option B

- Yes—Can perform job with no additional training.
- No—is unable to perform job satisfactorily.

**Automatic Dryers
Unit 8**

Written Test

Name _____ Date _____ Score _____

1. Match each term on the right with its correct definition.

- | | | |
|----------|---|--------------------|
| _____ a. | An appliance designed to dry wet clothes in a heat, air flow sequence in a drum that tumbles clothes as it rotates under control of a timer | 1. Cycle |
| _____ b. | The force that impels something outward from a rotating center | 2. Purging |
| _____ c. | One complete series of events that completes a procedure | 3. Automatic dryer |
| _____ d. | A continuous small flame used in gas appliances to ignite the gas burner (also called a pilot light) | 4. Pilot burner |
| _____ e. | Any procedure that cleans or removes obstructions such as removing air from a gas line | 5. Centrifugal |

2. Match major components with their functions in an automatic dryer.

- | | | |
|----------|---|----------------|
| _____ a. | The electromechanical brain of an automatic dryer that controls the sequence of functions | 1. Timer |
| _____ b. | Turns the drum, controls the heat circuit, and drives the blower | 2. Thermostats |
| _____ c. | An electric dryer uses an electric heating element and a gas dryer uses a gas valve and burner assembly | 3. Heat source |
| _____ d. | Devices that sense temperature and open or close to energize or de-energize the heat circuit | 4. Motor |

Written Test

3. Arrange in order the steps in automatic dryer operation. Place the correct sequence number in the correct blank.
- _____ a. The drying cycle runs for a selected length of time and is controlled by the drive motor.
 - _____ b. As the drum rotates, air is circulated into the drum to provide proper heat.
 - _____ c. During the last five minutes, the starting switch circuit opens, heat stops and dissipates, and cooler air flows through the clothes as the tumbling action continues until the cycle is complete.
 - _____ d. When the dryer starts, timer contacts energize the drive motor circuits.
 - _____ e. Through a series of motors or belts, the drive motor rotates the drum and causes clothes inside to tumble.
 - _____ f. In a normal cycle, after the motor circuits are energized, another set of contacts in the timer energize the dryer heat circuit.
4. Complete statements about thermostats and their functions in a dryer. Insert the word(s) that best completes each of the following statements.
- a. Cycling thermostats in a dryer help maintain a _____ heat level inside the drum when clothes are tumbling.
 - b. The safety or _____ thermostat shuts the dryer heat circuit off when there is evidence the dryer may overheat.
 - c. Cycling thermostats are mounted in or on the air _____ so they can sense both the temperature and moisture level of the air in the drum.
 - d. As the temperature in the drum reaches the limits of a cycling thermostat setting, the thermostat de-energizes the heat circuit and will remain open until the air cools sufficiently, and then close to _____ the circuit again.
 - e. The number of _____ thermostats in a dryer may vary, but many have low heat, medium heat, and high heat thermostats to provide the user with temperatures for a variety of fabrics.
5. Complete statements about troubleshooting a dryer that will not run. Insert the word(s) that best completes each of the following statements.
- a. Make sure the dryer is plugged into a proper _____ source, and then check the branch circuit control.
 - b. Check for _____ wires at terminals and run a continuity check on the circuitry to make sure there are no broken wires.

Written Test

- c. Check for a faulty door switch by first making sure the door is properly shut and then running a _____ check on the door switch, and replace as required.
 - d. Check motor wiring and motor _____ switch, and replace motor or switch as required.
 - e. Check the timer and timer circuitry and replace the timer _____ or the timer as required.
6. Select true statements about troubleshooting a dryer that will run but not heat. Place an "X" beside each true statement.
- _____ a. Check for loose wires on terminals and run a continuity check to make sure there are no broken wires.
 - _____ b. On an electric dryer, check for a proper 120V power supply.
 - _____ c. Check for defective thermostats and replace as required.
 - _____ d. Check for a wrong setting on the heat switch or check the heat switch itself and replace as required.
 - _____ e. Check timer and timer wiring and replace timer motor or entire timer as required.
 - _____ f. Check the centrifugal switch, if it is the type of motor that has one, and replace as required.
 - _____ g. Check for an open heater element and replace heater element as required.
 - _____ h. On a gas model, check the gas supply and make sure the gas supply valve is open.
 - _____ i. If the gas model has a pilot light that is out, replace the gas valve.
 - _____ j. Check for a defective solenoid coil in the gas valve by testing the coil for an open circuit, and replace the solenoid, if required, or the entire gas valve.
 - _____ k. Check for a defective flame switch.
 - _____ l. Check for a malfunctioning igniter.

Written Test

7. Complete statements about troubleshooting a dryer when the motor runs but the drum will not rotate. Insert the word(s) that best completes each of the following statements.
- a. Check for a slipping or broken _____ and adjust or replace as required.
 - b. Check for a loose _____ and tighten the _____ on the motor shaft.
 - c. Check for _____ objects that may be obstructing drum movement and remove them.
 - d. Check for a frozen _____ and replace as required.
 - e. Check for _____ and adjust or replace.
8. Complete statements about troubleshooting a dryer that runs but will not shut off. Insert the word(s) that best completes each of the following statements.
- a. Check to see if one side of the _____ circuit control is tripped open.
 - b. Check for a defective timer and replace timer _____ or timer as required.
9. Select true statements about troubleshooting a dryer that runs and heats but will not dry clothes. Place an "X" beside each true statement.
- ____ a. Check for a clogged lint screen and clean or replace as required.
 - ____ b. Check for a bad door switch.
 - ____ c. Check for incorrect heat or timer setting and reset as required.
 - ____ d. Check for a leaky door seal and if the door seal leaks air, replace it.
 - ____ e. Check for a bad centrifugal switch.
 - ____ f. Check for a fan or pulley loose on its shaft and tighten as required to restore good air motion in the drum.
 - ____ g. Check for defective operating thermostats, and if any of the thermostats are cycling too soon or too late, replace them.
 - ____ h. Find out if clothes were too wet when placed into the drum, and encourage customer to make sure clothes are properly wrung out before placing them in the dryer.

204

Written Test

10. Match other dryer problems with their solutions. Place the number beside the problem in the blank beside its solution.

- | | | | | |
|---------|-----|--|----|---|
| _____a. | (1) | Check wiring for bare spots that may be touching the frame. | 1. | Motor runs when door is open and timer |
| | (2) | Check for a sagging drum that may be causing the heater element to touch its housing. | 2. | Dryer heats with door open or in OFF cycle |
| | (3) | Check heater element for foreign matter. | 3. | Dryer repeatedly blows fuses or trips breaker |
| _____b. | (1) | Check for a defective door switch and replace as required. | 4. | Drum inspection light is burned out |
| | (2) | Check for a dial that binds because it is too far out from the control panel, and relocate the dial on the timer shaft to eliminate binding. | | |
| _____c. | | Replace the bulb. | | |
| _____d. | (1) | Check centrifugal switch. | | |
| | (2) | Check for malfunctioning heating element. | | |

11. Complete statements about troubleshooting gas valves and igniters on gas dryers. Insert the word(s) that best completes each of the following statements.

- a. Make sure _____ is turned off.
- b. When a test shows that there is voltage to a gas valve but there is no flame, the problem is in the gas valve circuitry and the _____ valve should be replaced.
- c. The igniter is _____ in the field, but a continuity test should indicate a resistance between 50 to 400 ohms, and if continuity is otherwise, the igniter also should be replaced.
- d. When installing a gas dryer or when relighting one that has been repaired, purge the gas line with the following procedure:
- (1) Turn the _____ off.
- (2) _____ the connection between the shut-off valve and the burner.

Written Test

- (3) Turn gas on until you _____ or _____ gas at the loose connection, turn the gas off, and tighten the connection.

12. Match special gas dryer problems with their solutions. Place the number beside the problem in the blank beside its solution.

- | | | |
|----------|--|---|
| _____ a. | <p>(1) Check for insufficient gas supply, low gas pressure, a clogged pilot filter, or a closed or partially closed gas supply valve.</p> <p>(2) Check for excessive carbon build-up on the thermocouple and clean as required.</p> <p>(3) Check for a faulty thermocouple and replace as required.</p> <p>(4) Readjust pilot flame until a faint yellow tip appears.</p> <p>(5) Check for a faulty ignition or reset valve and replace as required.</p> <p>(6) Check for excessive back drafts.</p> | <p>1. Pilot burner is okay but main burner does not light</p> <p>2. Main burner goes out after lighting</p> <p>3. Pilot burner goes out</p> <p>4. Main burner cycles too fast</p> <p>5. Pilot burner does not light</p> |
| _____ b. | <p>(1) Check for a closed or partially closed gas supply valve, a clogged pilot filter, or an obstruction in the gas supply line.</p> <p>(2) Check setting on pilot switch and reset as instructions direct.</p> | |

Written Test

- ____c.
- (1) Check for insufficient gas supply, a partially closed gas supply valve, or an obstruction in the gas supply line.
 - (2) Check for a defective safety thermostat and replace as required.
 - (3) Check for incorrect air supply and readjust the air shutter on the gas burner until a bright blue flame appears.
 - (4) Check gas valve solenoid and replace solenoid as required or replace gas valve.
- ____d.
- (1) Check for loose connections at wiring terminals and tighten as required.
 - (2) Check for a faulty timer and replace timer motor or timer as required.
 - (3) Check for a faulty operating thermostat and replace as required.
 - (4) Check safety thermostat for erratic cycling because of restricted air flow, and clean lint or obstructions from the dryer as required.
 - (5) Check safety thermostat for proper operation and replace as required.
- ____e.
- (1) Check for low gas pressure, partially closed gas supply valve, or an obstruction in the gas supply line.

Written Test

- (2) Check the primary air adjustment and adjust the air shutter until a bright blue flame appears at the main burner.
- (3) Check for loose connections at terminals and tighten as required.

Permission to duplicate this test is granted.

208

Automatic Dryers
Unit 8

Answers to Written Test

1. a. 3
 b. 5
 c. 1
 d. 4
 e. 2
2. a. 1
 b. 4
 c. 3
 d. 2
3. a. 5 d. 1
 b. 3 e. 2
 c. 6 f. 4
4. a. constant
 b. limiting
 c. exhaust duct
 d. energize
 e. cycling
5. a. power
 b. loose
 c. continuity
 d. centrifugal
 e. motor
6. a, c, d, e, f, g, h, j, k, l
7. a. belt
 b. pulley, pulley
 c. foreign
 d. bearing
 e. tension
8. a. branch
 b. motor
9. a, c, d, f, g, h
10. a. 3
 b. 1
 c. 4
 d. 2

209

Answers to Written Test

11. a. gas
b. entire
c. serviceable
(1) gas
(2) loosen
(3) hear, smell
12. a. 3
b. 5
c. 1
d. 4
e. 2

210

**Automatic Dryers
Unit 8**

Unit Evaluation Form

Name _____ Unit Rating _____

Job Sheet Ratings

Job Sheet 1—Install an Automatic Dryer Rating _____

Comments: _____

Job Sheet 2—Troubleshoot a Whirlpool/Kenmore Automatic Dryer
for Typical Malfunctions Rating _____

Comments: _____

Job Sheet 3—Troubleshoot a GE/Hotpoint Automatic Dryer for
Typical Malfunctions Rating _____

Comments: _____

Job Sheet 4—Troubleshoot a Microprocessor Control for Typical
Malfunctions Rating _____

Comments: _____

Written Test Scores

Pretest _____ Posttest _____ Other _____

Other _____

Teacher Signature _____ Date _____

Student Signature _____ Date _____

Permission to duplicate this form is granted.

**Automatic Dishwashers
Unit 9**

Unit Contents

Teacher Components

	Teacher Page
1. Suggested Activities	
a. Instructional Plan.....	1
b. Teaching Suggestions.....	2
c. Resources Used in Developing This Unit	2
d. Suggested Supplemental Resources	2
e. Instructions for Evaluating Student Performance	3
2. Written Test	5
3. Answers to Written Test.....	13
4. Unit Evaluation Form	15

Student Components

1. Objective Sheet	MAR-319
2. Information Sheet	MAR-321
3. Job Sheets	
JS 1—Install an Automatic Dishwasher Under a Counter	MAR-333
JS 2—Troubleshoot Malfunctions on an Automatic Dishwasher.....	MAR-343
JS 3—Troubleshoot the Seal on an Automatic Dishwasher.....	MAR-357

Automatic Dishwashers Unit 9

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction.
2. Review Teaching Suggestions. Plan for classroom activities.
3. Plan for students with special needs.
4. Obtain films, videotapes, and other resources to supplement instruction of this unit. See Resources and Suggested Supplemental Resources for more information.
5. Develop teaching plan. Adjust for different learning styles.
6. Review Instructions for Evaluating Student Performance.
7. Make copies of the Unit Evaluation Form, one for each student.

Delivery and Application

8. Provide students with unit of instruction.
9. Discuss unit and specific objectives.
10. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
11. Discuss and demonstrate the job sheets. Make sure all required tools, equipment, and supplies are available. Review criteria for evaluation of these activities.

Evaluation

12. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.
13. Make copies of the written test. Add or modify test items as needed.
14. Give written test.

Suggested Activities

15. Compile job sheet ratings and written test scores on the Unit Evaluation Forms. Include any additional assignments or supplemental activities that should be part of the unit evaluation.
16. Reteach and retest as required.

Teaching Suggestions

1. Invite an automatic dishwasher manufacturer's representative to talk to the class about dishwasher design and operation. **Basic skills, listening.**
2. Invite a local or area appliance repair technician to talk to the class about typical automatic dishwasher problems and how to troubleshoot them most effectively. **Basic skills, listening; thinking skills, knowing how to learn.**

Resources Used in Developing This Unit

1. Anderson, Edwin P. *Home Appliance Servicing*. Indianapolis, IN: Howard W. Sams & Co., Inc., 1974.
2. Meyerink, George. *Appliance Service Handbook*. Englewood Cliffs, NJ: Prentice Hall, Inc., 1973.

Suggested Supplemental Resources

1. Service literature for Frigidaire dishwashers is available from:

Frigidaire Company
6000 Perimeter Drive
Dublin, OH 43017
1-614-764-8640
2. Service literature for GE dishwashers is available from:

Dri-View Mfg. Co.
4706 Allmond Ave.
Louisville, KY 40209

or from the GE Parts Dept., 1-800-626-2002
3. Service literature price lists for Maytag and Norge dishwashers are available from:

Maytag Customer Service
Maytag Appliances
240 Edwards Street, S.E.
Cleveland, TN 37311
1-423-478-6788

Suggested Activities

4. Consumer services literature catalogs and service literature price lists for Whirlpool and KitchenAid dishwashers are available from:

Whirlpool Corporation
Literature Department
1900 Whirlpool Dr.
LaPorte, IN 46350-2585
1-800-851-4605

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

- 4 Skilled—Can perform job with no additional training.
- 3 Moderately skilled—Has performed job during training program; limited additional training may be required.
- 2 Limited skill—Has performed job during training program; additional training is required to develop skill.
- 1 Unskilled—is familiar with process, but is unable to perform job.

Option B

- Yes—Can perform job with no additional training.
- No—is unable to perform job satisfactorily

Automatic Dishwashers
Unit 9

Written Test

Name _____ Date _____ Score _____

1. Match each term on the right with its correct definition.

- | | | |
|----------|---|-------------------|
| _____ a. | Water containing mineral salts in quantities enough to interfere with lathering, sudsing, or cleaning properties of soaps and detergents | 1. Water softener |
| _____ b. | Water such as rainwater that contains none or few mineral salts | 2. Soft water |
| _____ c. | A mineral deposit that remains after a substance containing calcium carbonate is subjected to heat | 3. Rinsing agent |
| _____ d. | Any chemical that removes mineral salts from water or a filtering device that uses chemicals to remove minerals from water | 4. Hard water |
| _____ e. | The process of running cold water out of a hot water supply line to assure that only hot water of a desired temperature will be available | 5. Lime build-up |
| _____ f. | Chemicals added to water during a rinse cycle to enhance removal of chemical or detergent residue from dishes | 6. Purge |

Written Test

2. Match major components of a dishwasher with their functions. Place the number beside the component in the blank beside its function.

- | | | |
|---------|--|--------------------|
| _____a. | The electromechanical "brain" of an automatic dishwasher because it controls the operations of other components in a predetermined sequence | 1. Drain valve |
| _____b. | Controls water flow through the inlet hose into the tub | 2. Inlet valve |
| _____c. | The source of power for driving the impeller that spins to complete the washing cycle | 3. Door/lid switch |
| _____d. | The device that maintains water temperature and provides heat for the hot air used during the drying cycle | 4. Timer |
| _____e. | Forces water through the spray arms during the wash and rinse cycles and forces water and food particles out of the dishwasher during pumpout | 5. Dispensers |
| _____f. | Perforated extensions that reach out horizontally below and above the dishracks to provide a route for the revolving pressurized hot water that is sprayed onto the dishes | 6. Motor |
| _____g. | The device that separates food particles from the water so they will not be sprayed back onto the dishes | 7. Float switch |
| _____h. | Directs dirty water and food particles away from the dishwasher into a drain system | 8. Heating element |
| _____i. | Keeps the tub from filling until the door is closed to eliminate the prospects that water will spray out of an open door or lid into the kitchen | 9. Filter |
| _____j. | Devices for releasing detergent and rinsing agent | 10. Spray arms |
| _____k. | Safety device to prevent overfilling | 11. Pump |

217

Written Test

3. Arrange in order the typical steps in an automatic dishwasher cycle. Place the correct sequence number in the correct blank.

- ____ a. The upper spray arm deflects the water back down over the dishes and the washing action between the lower and upper spray arms is repeated over and over again.
- ____ b. As water runs off the dishes, it flows through a filtering system to keep food particles from being sprayed back onto the dishes.
- ____ c. Rinse conditioner should be added as recommended or as local water conditions demand.
- ____ d. Water enters the tub through the inlet hose and inlet valve until there is approximately two gallons of water in the tub.
- ____ e. Dirty dishes should be properly arranged in the dishracks.
- ____ f. Detergent as recommended by the manufacturer, and in the proper quantity, should be placed in the detergent dispenser.
- ____ g. As each wash or rinse cycle ends, water is pumped out of the dishwasher and small food particles are flushed away with it.
- ____ h. As the drying cycle starts, the heating element comes on so that hot air can be circulated over and around the dishes to help dry them.
- ____ i. The heating element is energized to assure that the water will be at least 140°F.
- ____ j. The motor is energized and pumps hot water through the lower spray arm in a jet stream and over the dishes to the upper spray arm.

4. Complete statements about special considerations for dishwasher installation. Insert the word(s) or figure(s) that best completes each of the following statements.

- a. There must be a proper _____ power supply, and it is recommended that the circuit be equipped with a 15-amp time delay fuse.
- b. Dishwasher must be properly _____.
- c. _____ cords should not be used to extend the power supply because they usually result in low line voltage.
- d. _____ line voltage does not permit the motor to operate at its rated capacity and results in poor washing action and water circulation.
- e. A dishwasher should be installed only on a sturdy, level floor in a well _____ area.

Written Test

- f. Dishwasher drain hookups must be _____ the equipment and free of obstructions that might impair proper drainage.
- g. The water supply must have a minimum flow rate of three gallons per minute and a minimum pressure of _____ psi.
- h. Water supply must also be in the range of _____ °F to _____ °F because some detergents will not dissolve and work at lower temperatures, and the higher temperature also helps in the drying cycle.
5. Select true statements about water problems with dishwashers. Place an "X" beside each true statement.
- _____ a. Loading patterns vary with design, so follow operator's manual carefully.
- _____ b. Stains on dishes result from poor detergent.
- _____ c. When piping is so old that rust cannot be controlled, it should be replaced.
- _____ d. Minerals in the water not only cause stains, they lead to lime build-up even in cases where the detergent recommended is designed to fight lime build-up.
- _____ e. Cleaning the dishwasher with a good detergent will help control lime build-up.
- _____ f. The best way to control stains, spots, and lime build-up is to install a new water line.
6. Complete statements about loading order in dishwasher operation. Insert the word(s) that best completes each of the following statements.
- a. Each model dishwasher has its own spray or splash pattern for water action and the order in which dishes are loaded must facilitate dishwasher _____.
- b. _____ is the best aid to proper placement, but generally, nothing should be placed on one rack that would block the flow of water to another rack.
- c. Cups and glasses and any containers that will retain water should always be placed _____ so water will drain from them and they will dry.
- d. Keep flatware and other utensils in their proper baskets because they can _____ seals and create problems if they are in the wrong place.

Written Test

7. Match common dishwasher misuses with their causes. Place the number beside the misuse in the blank beside its cause.

- | | | | |
|----------|--|----|---------------------------|
| _____ a. | Results from careless neglect of instructions or when dishes are loaded by a child or other person unfamiliar with loading order | 1. | Careless dish preparation |
| _____ b. | Results when dishes or utensils with dried food caked on them are not wetted and scraped before loading | 2. | Improper dishrack loading |
| _____ c. | Results when small bones or large seeds are carelessly left on dishes | 3. | Improper detergent use |
| _____ d. | Results when soap flakes or soap powders are used instead of the recommended detergent | 4. | Improper dish preparation |

8. Select true statements about guidelines for better dishwasher service. Place an "X" beside each true statement.

- _____ a. When a dishwasher is hooked up with a garbage disposer, the disposer should be completely empty so water will drain freely through the disposer.
- _____ b. Before starting the dishwasher, run hot water at the sink to purge cold water out of the line and assure that only hot water enters the dishwasher.
- _____ c. The same amount of water goes through a dishwasher each time it is used, so even when washing half a load, enough detergent for a full load should be placed in the dishwasher.

9. Complete statements about guidelines for troubleshooting automatic dishwashers. Insert the word(s) or figure(s) that best completes each of the following statements.

- a. Before assuming anything about a malfunctioning dishwasher, remember that almost _____% of dishwasher problems are not related to component failures.
- b. Check for a proper _____ V electrical power source.
- c. Check for a hot water supply of _____°F to _____°F and for a minimum water pressure of 15 psi.
- d. Check for a faulty floor that may be causing the dishwasher to _____ or a poor installation that does not provide ventilation.

Written Test

- e. Make sure the dishwasher is not being operated with improper _____ loaded improperly, or subjected to other forms of abuse.
 - f. Check the removable panel at the back or front of the machine for a schematic _____ and compare it with the operating sequence of the timer to systematically track down other problems.
 - g. Refer to the manufacturer's _____ chart for specific problems.
 - h. Look for leaks or broken parts, listen for parts that are binding, and generally use your senses and your _____ to diagnose the problem properly.
 - i. Check with customer to see if _____ or _____ use is depleting the hot water supply.
10. Complete a list of ways to prevent mineral build-up in an automatic dishwasher. Insert the word(s) that best completes each of the following statements.
- a. Check the washer at regular intervals for the presence of a white, brown, or yellow build-up in _____.
 - b. When build-up is enough that it can be readily detected, Whirlpool recommends the following procedure:
 - (a) empty the dishwasher and set it for a _____ wash cycle,
 - (2) start dishwasher, and then _____ the door so it will _____ when it has filled enough for the wash cycle,
 - (3) add half a cup of _____ acid crystals to the tub,
 - (4) close the door latch and allow the dishwasher to _____ the cycle, and
 - (5) run another complete _____ and _____ cycle to clean remaining residue from the tub and the drain system.
 - c. An alternate method of controlling lime build-up is to add two cups of distilled _____ to the tub instead of citric acid crystals.
 - d. In areas where a _____ stain is deposited on dishes, a quarter of a teaspoon of oxalic acid crystals used after dishes are washed should remove the iron deposits from the dishes.
 - e. Build-ups of tea stains on cups and saucers usually have to be removed by hand with a wash cloth saturated with _____.

Written Test

11. Complete statements about troubleshooting redeposit problems. Insert the word(s) that best completes each of the following statements.
- a. Because redeposits leave white spots on dishes, everyone assumes the spots are undissolved detergent, but they may be undissolved _____ from foods.
 - b. To isolate the problem, place a glass or dish under hot water:
 - (1) if the spots dissolve quickly in hot water, it is a _____ problem.
 - (2) if the spots stick to the glass or dish, they are food _____.
 - c. Detergent problems can be corrected by changing to a different detergent or mixing detergent with _____.
 - d. Food starch problems require better precleaning, especially with containers used for mashed potatoes, cooked cereals, cream soups, and any pudding or dessert that has a _____ base.
 - e. Both problems may be related to improper _____ and require adjustment of the _____ water supply control.

Permission to duplicate this test is granted.

Automatic Dishwashers
Unit 9

Answers to Written Test

- | | | | | |
|----|------------|--------------|----|-----------------|
| 1. | a. | 4 | d. | 1 |
| | b. | 2 | e. | 6 |
| | c. | 5 | f. | 3 |
| 2. | a. | 4 | g. | 9 |
| | b. | 2 | h. | 1 |
| | c. | 6 | i. | 3 |
| | d. | 8 | j. | 5 |
| | e. | 11 | k. | 7 |
| | f. | 10 | | |
| 3. | a. | 7 | f. | 2 |
| | b. | 8 | g. | 9 |
| | c. | 3 | h. | 10 |
| | d. | 4 | i. | 5 |
| | e. | 1 | j. | 6 |
| 4. | a. | 120V | | |
| | b. | grounded | | |
| | c. | Extension | | |
| | d. | Low | | |
| | e. | ventilated | | |
| | f. | near | | |
| | g. | 15 | | |
| | h. | 140, 160 | | |
| 5. | a, c, d, f | | | |
| 6. | a. | design | | |
| | b. | Common sense | | |
| | c. | upside down | | |
| | d. | puncture | | |
| 7. | a. | 2 | | |
| | b. | 4 | | |
| | c. | 1 | | |
| | d. | 3 | | |
| 8. | a, b, c | | | |
| 9. | a. | 75 | f. | wiring diagram |
| | b. | 120 | g. | service |
| | c. | 140, 160 | h. | common sense |
| | d. | vibrate | i. | shower, laundry |
| | e. | detergent | | |

Answers to Written Test

10. a. the tub
b. (1) one
(2) open, stop
(3) citric
(4) complete
(5) wash, rinse
c. white vinegar
d. brown
e. baking soda
11. a. starch
b. (1) detergent
(2) starches
c. water conditioner
d. cornstarch
e. water temperature, hot

**Automatic Dishwashers
Unit 9**

Unit Evaluation Form

Name _____ Unit Rating _____

Job Sheet Ratings

Job Sheet 1—Install an Automatic Dishwasher Under a Counter Rating _____

Comments: _____

Job Sheet 2—Troubleshoot Malfunctions on an Automatic Dishwasher Rating _____

Comments: _____

Job Sheet 3—Inspect the Seal on an Automatic Dishwasher Rating _____

Comments: _____

Written Test Scores

Pretest _____ Posttest _____ Other _____

Other _____

Teacher Signature _____ Date _____

Student Signature _____ Date _____

Permission to duplicate this form is granted.

225

**Garbage Disposers
Unit 10**

Unit Contents

Teacher Components

	Teacher Page
1. Suggested Activities	
a. Instructional Plan.....	1
b. Teaching Suggestions.....	2
c. Resources Used in Developing This Unit	2
d. Suggested Supplemental Resources	2
e. Instructions for Evaluating Student Performance	3
2. Written Test	5
3. Answers to Written Test.....	11
4. Unit Evaluation Form	13

Student Components

1. Objective Sheet	MAR-365
2. Information Sheet	MAR-367
3. Job Sheets	
JS 1—Install a Disposer to Manufacturer's Specifications	MAR-373
JS 2—Free a Jammed Garbage Disposer	MAR-383

**Garbage Disposers
Unit 10**

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction.
2. Review Teaching Suggestions. Plan for classroom activities.
3. Plan for students with special needs.
4. Obtain films, videotapes, and other resources to supplement instruction of this unit. See Resources and Suggested Supplemental Resources for more information.
5. Develop teaching plan. Adjust for different learning styles.
6. Review Instructions for Evaluating Student Performance.
7. Make copies of the Unit Evaluation Form, one for each student.

Delivery and Application

8. Provide students with unit of instruction.
9. Discuss unit and specific objectives.
10. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
11. Discuss and demonstrate the job sheets. Make sure all required tools, equipment, and supplies are available. Review criteria for evaluation of these activities.

Evaluation

12. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.
13. Make copies of the written test. Add or modify test items as needed.
14. Give written test.

Suggested Activities

15. Compile job sheet ratings and written test scores on the Unit Evaluation Forms. Include any additional assignments or supplemental activities that should be part of the unit evaluation.
16. Reteach and retest as required.

Teaching Suggestions

1. Invite a garbage disposer manufacturer's representative to talk to the class about garbage disposer design and operation. **Basic skills, science and listening.**
2. Invite a local or area appliance repair technician to talk to the class about typical disposer problems and how best to troubleshoot them. **Basic skills, science; Thinking skills, knowing how to learn.**

Resources Used in Developing This Unit

1. Anderson, Edwin P. *Home Appliance Servicing*. Indianapolis, IN: Howard W. Sams & Co., Inc., 1974.
2. Meyerink, George. *Appliance Service Handbook*. Englewood Cliffs, NJ: Prentice Hall, Inc., 1973.

Suggested Supplemental Resources

1. Service literature for Frigidaire disposers is available from:

Frigidaire Company
6000 Perimeter Drive
Dublin, OH 43017
1-614-764-8640
2. Service literature for GE disposers is available from:

Dri-View Mfg. Co.
4706 Allmond Ave.
Louisville, KY 40209

or from the GE Parts Dept., 1-800-626-2002
3. Repair manuals for In-sink-erator disposers are available from:

In-sink-erator
Service Department
4700 21st
Racine, WI 53406
1-800-558-5700

228

Suggested Activities

4. Service literature price lists for Maytag disposers are available from:

Maytag Customer Service
Maytag Appliances
240 Edwards Street, S.E.
Cleveland, TN 37311
1-423-478-6788

5. Consumer services literature catalogs and service literature price lists for Whirlpool and KitchenAid disposers are available from:

Whirlpool Corporation
Literature Department
1900 Whirlpool Dr.
LaPorte, IN 46350-2585
1-800-851-4605

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

- 4 Skilled—Can perform job with no additional training.
- 3 Moderately skilled—Has performed job during training program; limited additional training may be required.
- 2 Limited skill—Has performed job during training program; additional training is required to develop skill.
- 1 Unskilled—is familiar with process, but is unable to perform job.

Option B

- Yes—Can perform job with no additional training.
- No—is unable to perform job satisfactorily

229

Garbage Disposers
Unit 10

Written Test

Name _____ Date _____ Score _____

1. Match each term on the right with its correct definition.

- | | | |
|----------|---|--------------------|
| _____ a. | A disposer type that uses a lid that locks in place to start the motor or unlocks to stop the motor so that waste cannot be fed into the disposer while it is running | 1. Septic tank |
| _____ b. | A disposer type that uses an ON/OFF switch and appropriate safeguards so that waste can be fed into the disposer while it is running | 2. Continuous feed |
| _____ c. | That which can be readily decomposed through natural biological processes | 3. Local codes |
| _____ d. | Legal guidelines for electrical and plumbing installations in a specific town, city, or geographic area where local geography may impose special needs on such installations | 4. Trap |
| _____ e. | A holding facility for waste matter that is directed into lateral pipes placed in a sand/gravel bed to accomplish waste disposal in areas where waste cannot be fed into a sewer line | 5. Batch feed |
| _____ f. | That part of a drain pipe so shaped that water will stand in it to help seal off offensive odors that could otherwise return from a sewer or septic system | 6. Biodegradable |

2. Complete statements about first considerations for garbage disposers. Insert the word(s) that best completes each of the following statements.

- a. Automatic garbage disposers and automatic dishwashers are the two appliances most subject to failure because of _____ use or outright _____ by their operators.
- b. Customers having a new disposer installed should be carefully instructed in its proper use and the _____ improper use can pose to both the equipment and the customer.

Written Test

3. Complete a list of safety rules for disposer operation. Insert the word(s) that best completes each of the following statements.

- a. NEVER place your hand in a garbage disposal even when the disposer is _____.
- b. ALWAYS run _____ water when the disposer is operating.
- c. NEVER use any kind of _____ to unjam a clogged garbage disposer.

4. Match major components of a garbage disposer with their functions. Place the number beside the component in the blank beside its function.

- | | |
|---|--------------------|
| _____ a. Contains the drive motor, stationary shredding ring, and flywheel | 1. Mounting flange |
| _____ b. Contains the starting controls, the impeller, and serves as the hopper into which wastes are placed | 2. Insulation |
| _____ c. Principle part of the disposer that provides the high torque required to drive the impeller | 3. Impeller |
| _____ d. A circular device driven by the motor shaft to provide inertia and to compensate for fluctuations in operating speeds | 4. Lower housing |
| _____ e. A stationary device circling the interior of the housing and so positioned that the impeller forces waste matter against its cutting edges | 5. Tailpiece |
| _____ f. A rotating disk with projections that force waste against the shredding ring | 6. Drive motor |
| _____ g. The top lip of a disposer that is secured over a gasket and tightened to a support ring so that the disposer can be easily installed in a kitchen sink | 7. Upper housing |
| _____ h. The drain outlet of the disposer that permits easy hookup to existing plumbing with a slip-joint plumbing connection | 8. Flywheel |
| _____ i. Surrounds lower housing and helps to keep down the noise of the motor and grinding sounds | 9. Shredding ring |

Written Test

5. Arrange in order the steps in garbage disposer operations. Place the correct sequence number in the correct blank.

- _____ a. The drive motor starts rotating.
- _____ b. Centrifugal force impels garbage outward from the rotating flywheel.
- _____ c. Garbage is placed into the disposer.
- _____ d. Garbage is shredded into small pieces as it is forced into the cutting edges of the shredding ring by the action of the impeller.
- _____ e. The shredded garbage is washed down through holes in the flywheel strainer plate and on out into the plumbing drain.
- _____ f. The cold water is turned on.
- _____ g. The disposer cover is put in place and turned clockwise to activate the starting control switch, if it is a batch feed model.

6. Complete statements about the importance of cold water flow in a disposer. Insert the word(s) or figure(s) that best completes each of the following statements.

- a. Cold water is required as a _____ agent to carry ground-up waste away.
- b. Cold water is required to _____ grease that may be placed into the disposer so that grease can be shredded and washed away like other waste.
- c. Cold water also _____ the motor shaft that turns the impeller so it will not overheat.
- d. Cold water should be allowed to continue to flow about _____ after all waste has been completely shredded so that the drain line will be completely flushed of waste.

7. Complete a list of common misuses that cause disposer problems. Insert the word(s) that best completes each of the following statements.

- a. _____ with waste is probably the biggest cause of disposer problems.
- b. Failure to run sufficient _____ during disposer operation is probably the second biggest cause of disposer problems.
- c. Injecting inorganic materials such as glass or _____ items such as silverware cause a disposer to jam and lead to other major problems.
- d. Cloth, paper, and even _____ can cause a disposer to jam and lead to other major problems

Written Test

- e. Chemicals used to clean clogged drains should never be placed in a disposer because they will damage _____ and _____ seals and corrode metal parts.
8. Select true statements about items that can be placed into a garbage disposer. Place an "X" beside each true statement.
- _____ a. Waste vegetables and meat scraps
 - _____ b. Waste scraps of bread, potato and fruit peelings, and fruit seeds
 - _____ c. Bones of all sizes
 - _____ d. Waste grease and fats
 - _____ e. All other soluble food wastes
9. Complete statements about guidelines for handling a jammed garbage disposer. Insert the word(s) that best completes each of the following statements.
- a. The most _____ problem with garbage disposers is that they get jammed with food waste and have to be unjammed.
 - b. When a disposer jams, always turn the disposer off, allow the motor to cool, and then press the _____.
 - c. Turn on the motor-reversing switch, if the disposer has that feature, and permit the impeller to run in _____ until it is unjammed.
 - d. On models without a motor-reversing switch, turn the machine off, insert an unjamming tool, and _____ turn the impeller backwards.
 - e. Attempt to run the motor _____ to complete shredding of the obstacle that caused the jamming.
 - f. If the obstacle jams the disposer again, turn the disposer off, repeat the procedure for freeing the impeller, but this time, reach in with a _____ and remove the obstruction.
10. Select true statements about guidelines for installing a garbage disposer. Place an "X" beside each true statement.
- _____ a. Check the power supply to make sure it agrees with the voltage and frequency listed on the motor nameplate.
 - _____ b. Make sure the disposer is properly grounded.
 - _____ c. Existing plumbing should be carefully examined to make sure it is suitable for installation, and make sure local codes do not prohibit a disposer installation.

Written Test

- _____d. The disposer should be hooked up to a trap that serves another piece of equipment such as a washing machine.
 - _____e. Unless codes require them, remove old grease traps, and if they are required, advise the customer to clean the trap every 90 days.
 - _____f. Septic systems must have a minimum capacity of 100 gallons before a garbage disposer can function properly.
 - _____g. Encourage customers with septic systems to avoid placing anything into the disposer that is not biodegradable.
11. Complete statements about guidelines for troubleshooting disposer malfunctions. Insert the word(s) that best completes each of the following statements.
- a. Always _____ the power before inserting any kind of tool into the disposer.
 - b. Check first to see that the _____ is free to turn and unjam it if it is obstructed.
 - c. Permit the motor to _____ if it has been running and then push the reset button.
 - d. Make sure a proper 120V power supply is reaching the motor because _____ line voltage will cause a motor to overheat and stop.
 - e. Check for a blown _____.
 - f. Check for loose wires at _____.
 - g. If all else seems to be in order, check all _____ by disconnecting the power supply and making continuity checks.
 - h. If _____ appear to be okay, the _____ itself will have to be checked.
 - i. Continue with _____ as the problem demands.
 - j. Make sure the power supply and disposer are safely _____.

Permission to duplicate this test is granted.

Garbage Disposers
Unit 10

Answers to Written Test

- | | | | | |
|-----|---------------|-----------------|----|---|
| 1. | a. | 5 | d. | 3 |
| | b. | 2 | e. | 1 |
| | c. | 6 | f. | 4 |
| 2. | a. | improper, abuse | | |
| | b. | dangers | | |
| 3. | a. | disconnected | | |
| | b. | cold | | |
| | c. | silverware | | |
| 4. | a. | 4 | f. | 3 |
| | b. | 7 | g. | 1 |
| | c. | 6 | h. | 5 |
| | d. | 8 | i. | 2 |
| | e. | 9 | | |
| 5. | a. | 4 | e. | 7 |
| | b. | 5 | f. | 2 |
| | c. | 1 | g. | 3 |
| | d. | 6 | | |
| 6. | a. | transporting | | |
| | b. | solidify | | |
| | c. | cools | | |
| | d. | 30 seconds | | |
| 7. | a. | Overloading | | |
| | b. | water | | |
| | c. | metallic | | |
| | d. | string | | |
| | e. | rubber, fiber | | |
| 8. | a, b, d, e | | | |
| 9. | a. | common | | |
| | b. | reset button | | |
| | c. | reverse | | |
| | d. | manually | | |
| | e. | forward | | |
| | f. | pair of tongs | | |
| 10. | a, b, d, e, g | | | |

Written Test

11. a. disconnect
 b. impeller
 c. cool off
 d. low
 e. fuse
 f. terminals
 g. switches
 h. switches, motor
 i. troubleshooting
 j. grounded

230

**Garbage Disposers
Unit 10**

Unit Evaluation Form

Name _____ Unit Rating _____

Job Sheet Ratings

Job Sheet 1—Install a Disposer to Manufacturer's Specifications Rating _____

Comments: _____

Job Sheet 2—Free a Jammed Garbage Disposer Rating _____

Comments: _____

Written Test Scores

Pretest _____

Posttest _____

Other _____

Other _____

Teacher Signature _____ Date _____

Student Signature _____ Date _____

Permission to duplicate this form is granted.

**Trash Compactors
Unit 11**

Unit Contents

Teacher Components

	Teacher Page
1. Suggested Activities	
a. Instructional Plan.....	1
b. Teaching Suggestions.....	2
c. Resources Used in Developing This Unit	2
d. Suggested Supplemental Resources	2
e. Instructions for Evaluating Student Performance	3
2. Answers to Assignment Sheets	5
3. Written Test	7
4. Answers to Written Test.....	15
5. Unit Evaluation Form	17

Student Components

1. Objective Sheet	MAR-385
2. Information Sheet	MAR-387
3. Assignment Sheets	
AS 1—Use Schematics to Determine Operating Conditions on a Trash Compactor	MAR-399
4. Job Sheets	
JS 1—Install an Undercounter Trash Compactor to Specifications	MAR-403
JS 2—Test the Drive Motor on a Trash Compactor to Determine Its Operational Condition.....	MAR-411
JS 3—Troubleshoot a Trash Compactor for Typical malfunctions	MAR-415

**Trash Compactors
Unit 11**

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction.
2. Review Teaching Suggestions. Plan for classroom activities.
3. Plan for students with special needs.
4. Obtain films, videotapes, and other resources to supplement instruction of this unit. See Resources and Suggested Supplemental Resources for more information.
5. Develop teaching plan. Adjust for different learning styles.
6. Review Instructions for Evaluating Student Performance.
7. Make copies of the Unit Evaluation Form, one for each student.

Delivery and Application

8. Provide students with unit of instruction.
9. Discuss unit and specific objectives.
10. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic workplace skills when applicable.
11. Discuss the assignment sheet. Review criteria for evaluation of this activity.
12. Discuss and demonstrate the job sheets. Make sure all required tools, equipment, and supplies are available. Review criteria for evaluation of these activities.

Evaluation

13. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.
14. Make copies of the written test. Add or modify test items as needed.
15. Give written test.
16. Compile assignment sheet ratings, job sheet ratings, and written test scores on the Unit Evaluation Forms. Include any additional assignments or supplemental activities that should be part of the unit evaluation.

Suggested Activities

Teaching Suggestions

1. Invite a technician who has worked on trash compactors to talk to the class about compactor repairs and problems that are peculiar to trash compactors. **Basic skills, listening and science.**
2. Impress upon students the importance of blocking up the ram when working on a trash compactor, and other dangers such as bits of glass that may still be in the trash drawer. **Personal management skill, responsibility.**
3. Show a sample of multipurpose molybdenum grease and explain how its high pressure service characteristics make it a vital lubricant for proper trash compactor maintenance. **Basic skills, science.**
4. Show the class samples of worn power screws and demonstrate how they can be replaced. **Thinking skills, knowing how to learn.**

Resources Used in Developing This Unit

1. Anderson, Edwin P. *Home Appliance Servicing*. Indianapolis, IN: Howard W. Sams & Co., Inc., 1974.
2. *Do-It-Yourself Repair Manual for Your Whirlpool Trash Masher Compactor*. Benton Harbor, MI: Whirlpool Corporation, 1984.
3. *Tech Talk Trash Compactor*. Dayton, OH: Frigidaire Parts and Service Company.

Suggested Supplemental Resources

1. Service literature for Frigidaire compactors is available from:

Frigidaire Company
6000 Perimeter Drive
Dublin, OH 43017
1-614-764-8640

2. Service literature for GE compactors is available from:

Dri-View Mfg. Co.
4706 Allmond Ave.
Louisville, KY 40209

or from the GE Parts Dept., 1-800-626-2002

Suggested Activities

3. Service literature price lists for Magic Chef compactors are available from:

Maytag Customer Service
Maytag Appliances
240 Edwards Street, S. E.
Cleveland, TN 37311
1-423-478-6788

4. Consumer services literature catalogs and service literature price lists for Whirlpool and KitchenAid compactors are available from:

Whirlpool Corporation
Literature Department
1900 Whirlpool Dr.
LaPorte, IN 46350-2585
1-800-851-4605

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

- 4 Skilled—Can perform job with no additional training.
- 3 Moderately skilled—Has performed job during training program; limited additional training may be required.
- 2 Limited skill—Has performed job during training program; additional training is required to develop skill.
- 1 Unskilled—is familiar with process, but is unable to perform job.

Option B

- Yes—Can perform job with no additional training.
- No—is unable to perform job satisfactorily

**Trash Compactors
Unit 11**

Answers to Assignment Sheets

Assignment Sheet 1

- A.
1. CW
 2. Closed
 3. Closed
 4. Closed
 5. No
- B.
1. The ram has compacted trash or hit the bumpers and the motor start switch has reversed
 2. Stop
 3. No
 4. No
- C.
1. The drawer tilt switch is open
 2. It is ON
 3. Bottles or other hard objects were loaded off center and forced the drawer forward enough that it could be damaged by the ram, and the cycle has stopped to protect the appliance

Trash Compactors
Unit 11

Written Test

Name _____ Date _____ Score _____

1. Match each term on the right with its correct definition.

- | | | |
|----------|---|-----------------|
| _____ a. | Stops so placed that the ram will strike them as it nears the bottom of the trash drawer and complete a full cycle even when there is less than a minimum load of trash | 1. Ram |
| _____ b. | Sprocketed rotating shafts that are chain or belt driven to build up the high torque required to power the ram | 2. Bumpers |
| _____ c. | A round or box-shaped welded steel component that is driven into the trash drawer to compact trash | 3. Trash drawer |
| _____ d. | A gasket-like attachment extending from all sides of the ram so that the walls of the trash drawer will be wiped clean during compaction | 4. Power screws |
| _____ e. | A welded steel drawer at the bottom of the compactor where trash bags are placed and from which full trash bags are removed | 5. Ram wiper |

2. Complete statements about trash compactor characteristics. Insert the word(s) that best completes each of the following statements.

- a. Trash compactors are designed to reduce trash to approximately _____ its original size and contain it in a leak resistant bag.
- b. Trash compactors also have built-in components to hold and disperse _____ to eliminate unpleasant odors.
- c. As a safety factor, almost all trash compactors must be turned on with a _____.
- d. Compactors also have built-in safety devices to protect the _____ from being damaged by the ram.
- e. Most trash compactors use special Kraft/polyethylene bags and _____ bags will not work properly.

Written Test

- f. Compactors are built with straight rams or scissor-type rams, but both types operate with _____ and have similar service characteristics.
3. Arrange in order steps in a typical compactor cycle. Place the correct sequence number in the correct blank.
- _____ a. As the motor reverses, the ram travels upward until it returns to the normal OFF or home position.
 - _____ b. The start switch must be depressed and held down until the ram travels $\frac{3}{4}$ ".
 - _____ c. The ram will travel downward until the motor is stalled by the action of compacting trash or by striking the four bumpers located in the frame channel.
 - _____ d. The trash drawer must be closed and the ram in home position.
 - _____ e. The key lock switch must be turned ON.
 - _____ f. The motor stall stops the clockwise motor starting switch and energizes the counterclockwise motor starting switch.
 - _____ g. The motor runs clockwise to engage the drive sprocket and chain to the power screws which in turn start the ram traveling downward.
4. Match compactor electrical components with their characteristics. Place the number beside the component in the blank beside its characteristic.
- | | | |
|----------|---|---|
| _____ a. | Key operated so that when turned to ON it energizes the motor and starts downward ram travel | 1. Drawer safety switch |
| _____ b. | Mounted on the front frame so that it is activated by ram movement to control motor direction which in turn controls the down/up ram movement | 2. Drive motor |
| _____ c. | Is energized anytime the drawer is improperly loaded or improperly closed to indicate a problem | 3. Start switch |
| _____ d. | Is energized anytime the load shifts forward in the drawer to stop the ram and prevent damage to both the drawer and the ram | 4. Drawer tilt switch |
| _____ e. | Usually a 1/3 HP that operates on 120V AC at 60 Hz | 5. Top limit and ram directional switch |

Written Test

5. Select true statements about trash compactor operating safety. Place an "X" beside each true statement.

- _____ a. All trash compactors should be properly grounded at the time of installation and checked for proper grounding after any repairs.
- _____ b. Children should be allowed to operate a trash compactor only after careful instruction.
- _____ c. Always wear gloves when unloading a trash bag because fragments of glass may be sticking through the bag.
- _____ d. Clean the trash drawer at regular intervals to keep down odors and maintain a sanitary appliance.
- _____ e. Provide as much ventilation space as possible around the compactor because compactor motors get demanding service and overheat easily.
- _____ f. Do not overload the trash drawer because the unit will not compact and it will cause excessive motor and power screw wear.
- _____ g. NEVER place aerosol cans in a trash compactor unless you know they are completely empty.

6. Complete statements about trash compactor service safety. Insert the word(s) that best completes each of the following statements.

- a. Always _____ the compactor from its _____ before making electrical tests.
- b. Block the _____ to assure that it will not accidentally fall on your hand.
- c. Tape the _____ of the top limit and directional switches when removing or reinstalling the ram because the _____ can be damaged.
- d. Never bypass or otherwise disable a _____ device for any reason.
- e. Always disconnect at least _____ when checking continuity on electrical switches.

7. List guidelines for properly loading a compactor. Insert the word(s) that best completes each of the following statements.

- a. Make sure the ram is in the _____ position.
- b. Place folded _____ in the bottom of the trash drawer to help minimize tears in the bag caused by glass or metal fragments.

Written Test

- c. Place _____ over bottles or light bulbs to keep broken glass within the trash bag.
- d. Lay large bottles _____ in the center and slightly to the rear of the trash drawer.
8. Complete statements about common causes for failure to compact. Insert the word(s) that best completes each of the following statements.
- a. The compact force developed by the ram is directly related to the _____ supplied to a unit while compacting action is in progress.
- b. Since force/voltage are directly related, _____ voltage while compacting is taking place will impair performance.
- c. Customer may be trying to compact too small a load because maximum ram travel is 5" less than the depth of the trash drawer and compaction cannot take place until drawer is at least _____ full.
- d. Customer may have bottles mixed in with a _____ load that prevents the bottles from breaking.
- e. Customer may be overloading the compactor to the point that the crushing resistance of the load is _____ than the crushing force of the ram.
9. Select true statements about major wear problems with compactors. Place an "X" beside each true statement.
- _____ a. Motor burnout may be a problem with trash compactors, and it can be caused by overloading or by overheating in poorly ventilated locations.
- _____ b. Power screws are subject to high torque stress and threads may strip.
- _____ c. Chains and belts break or go out of adjustment because they are subject to high torque stress.
- _____ e. Motors should be checked carefully before replacement.
- _____ f. Chains and belts cannot be adjusted so they should always be replaced.
10. Complete statements about lubrication requirements for compactors. Insert the word(s) that best completes each of the following statements.
- a. _____ should be lubricated with a multi-purpose molythium grease designed especially for high pressure applications.
- b. _____ on the trash drawer should be lubricated with SAE 30W oil.

Written Test

11. Complete statements about chain and belt adjustments. Insert the word(s) that best completes each of the following statements.
- a. Tightening loose belts or chains is best done by loosening the motor mount screws and _____ the motor as required.
 - b. Chains and belts should normally have a deflection of 3/8" to 1/2" at _____ between sprockets, but in all cases, check specifications.
12. Match compactor problems with troubleshooting guidelines. Place the number beside the guideline in the blank beside the problem.
- | | | |
|----------|--|--|
| _____ a. | (1) no power to the unit. | 1. When the compactor stops before the end of a cycle, troubleshoot for: |
| | (2) start switch not held to START, or not held in position long enough. | |
| | (3) defective start switch. | 2. When the drive screw runs the wrong way, troubleshoot for: |
| | (4) drawer not properly closed. | |
| | (5) defective drawer safety switch. | 3. When the compactor will not stop, troubleshoot for: |
| | (6) motor protector open. | |
| | (7) motor windings open. | 4. When the compactor reverses too soon, troubleshoot for: |
| | (8) top limit and ram directional switch defective. | |
| | (9) a loose connection or a broken wire. | 5. When the compactor will not start, troubleshoot for: |
| _____ b. | (1) a drive nut that has run off the top of the power drive screws. | |
| | (2) top limit and ram directional switch not properly adjusted or defective. | |
| | (3) start switch defective or momentary contact stuck closed. | |
| | (4) stripped threads on the power drive nuts, or stripped threads on the power drive screws. | |

Written Test

- _____c.
- (1) top limit and ram directional switch not properly adjusted or defective.
 - (2) drawer tilt switch open, usually indicated when the restart light comes on.
 - (3) drawer tilt switch open because the drawer has tilted because of an unbalanced load.
 - (4) motor protector open.
 - (5) a loose connection or broken wire.
 - (6) if the problem occurs at the reversing point, troubleshoot for a defective ram directional switch, a motor start switch stuck open, or a start winding open.
- _____d.
- (1) motor speed being dragged down by insufficient lubrication on power drive screws, nuts, and bearings.
 - (2) ram binding because of worn or missing glides.
 - (3) unusually dense load of too many cans or odd-shaped bottles.
 - (4) low voltage causing insufficient torque.
- _____e.
- (1) if it begins at the start of the cycle, the top limit ram directional switch is probably bad.
 - (2) if it happens during any part of the cycle, the top limit and directional switch may be wired improperly or the start windings may be reversed on the motor.

Written Test

13. Complete statements about guidelines for troubleshooting a noisy compactor. Insert the word(s) that best completes each of the following statements.

a. If the problem is at the start of the cycle and is accompanied by a thumping sound, the power drive screw nuts are probably _____ of the threads.

b. If the noise occurs during ram travel, troubleshoot for:

(1) _____ too tight or too loose.

(2) insufficient _____.

(3) worn power screw drive _____.

(4) worn _____ gear assembly.

(5) worn motor drive _____.

(6) worn thrust _____.

(7) loose or worn power drive _____.

c. If the noise occurs during the bottom of the cycle, troubleshoot for:

(1) worn _____.

(2) loading _____.

14. Complete statements about guidelines for troubleshooting other compactor problems. Insert the word(s) that best completes each of the following statements.

a. When the complaint is unpleasant odor in or around the compactor, troubleshoot for:

(1) garbage _____ the container.

(2) inside of _____ needs cleaning.

(3) _____ of cabinet needs cleaning.

(4) _____ needs to be replaced.

(5) garbage has been left standing _____.

Written Test

- b. When trash bags get tangled in the ram, troubleshoot for:
- (1) improperly _____ trash bag.
 - (2) _____ type of trash bag used.
15. Select true statements about items that should not be placed in a trash compactor. Place an "X" beside each true statement.
- _____ a. Soft food wastes should be disposed of in a garbage disposer because in a compactor they dirty the ram head.
 - _____ b. Fish and meat trimmings and citrus rinds quickly build up strong odors in a compactor and are best handled in a garbage disposer.
 - _____ c. Aerosol cans should be compacted only if they are completely empty.

Permission to duplicate this test is granted.

250

**Trash Compactors
Unit 11**

Answers to Written Test

1. a. 2
 b. 4
 c. 1
 d. 5
 e. 3

2. a. one-fourth
 b. deodorant
 c. key
 d. trash drawer
 e. substitute
 f. power screws

3. a. 7
 b. 3
 c. 5
 d. 1
 e. 2
 f. 6
 g. 4

4. a. 3
 b. 5
 c. 1
 d. 4
 e. 2

5. a, c, d, e, f

6. a. unplug, power source
 b. ram up
 c. switch arms, switch arms
 d. safety
 e. one terminal lead

7. a. home
 b. newspapers
 c. paper
 d. lengthwise

8. a. voltage
 b. low
 c. 1/3
 d. spongy
 e. greater

251

Answers to Written Test

9. a, b, c, d, e
10. a. power screws
b. slide rollers
11. a. moving
b. midpoint
12. a. 5
b. 3
c. 1
d. 4
e. 2
13. a. off the top
b. (1) chain
(2) lubrication
(3) bearings
(4) drive
(5) gear
(6) bearings
(7) screw nuts
c. (1) bumpers
(2) down
14. a. (1) outside
(2) drawer
(3) inside
(4) deodorizer
(5) too long
b. (1) installed
(2) wrong
15. a, b

**Trash Compactors
Unit 11**

Unit Evaluation Form

Name _____ Unit Rating _____

Assignment Sheet Ratings

Assignment Sheet 1—Use Schematics to Determine Operating
Conditions on a Trash Compactor Rating _____

Comments: _____

Job Sheet Ratings

Job Sheet 1—Install an Undercounter Trash Compactor to
Specifications Rating _____

Comments: _____

Job Sheet 2—Test a Drive Motor on a Trash Compactor to
Determine its Operating Condition Rating _____

Comments: _____

Job Sheet 3—Troubleshoot a Trash Compactor for Typical
Malfunctions Rating _____

Comments: _____

Written Test Scores

Pretest _____ Posttest _____ Other _____

Other _____

Teacher Signature _____ Date _____

Student Signature _____ Date _____

Permission to duplicate this form is granted.

**Gas Ranges and Ovens
Unit 12**

Unit Contents

Teacher Components

	Teacher Page
1. Suggested Activities	
a. Instructional Plan.....	1
b. Teaching Suggestions.....	2
c. Resources Used in Developing This Unit	3
d. Suggested Supplemental Resources	3
e. Instructions for Evaluating Student Performance	4
2. Transparency Masters	
TM 1—Types and Characteristics of Gases.....	5
TM 2—Nameplate Information	7
TM 3—Top Burner Operation	9
TM 4—Burner Types	11
TM 5—Automatic Oven Ignition System	13
TM 6—Semi-Automatic Oven Ignition System	15
TM 7—Manual Oven Ignition System.....	17
TM 8—Hydraulic Thermostat	19
TM 9—Electric-Hydraulic Thermostat	21
TM 10—Pneumatic Thermostat	23
TM 11—Circuit Operations During Bake Operation	25
TM 12—Circuit Operations During a Timed Bake Operation.....	27
TM 13—Circuit Operations During a Clean Operation	29
TM 14—Circuit Operations During Lock and Unlock Operations.....	31
TM 15—Manometer Pressure Equivalent Table	33
3. Answers to Assignment Sheets	35
4. Written Test	37
5. Answers to Written Test.....	55
6. Unit Evaluation Form	59

Student Components

1. Objective Sheet	MAR-419
2. Information Sheet	MAR-423

Unit Contents

3. Assignment Sheets

AS 1—Determine Voltage and Resistance Readings on a Self-Cleaning Gas Oven Set for a Bake Operations.....	MAR-447
AS 2—Determine Voltage and Resistance Readings on a Self-Cleaning Gas Oven Set for a Timed Bake Operation.....	MAR-451
AS 3—Determine Voltage and Resistance Readings on a Self-Cleaning Gas Oven Set for a Cleaning Operation.....	MAR-455
AS 4—Determine Voltage and Resistance Readings on a Self-Cleaning Gas Oven During Lock and Unlock.....	MAR-459

4. Job Sheets

JS 1—Install a Gas Range Level and Leak Free With All Burners Properly Adjusted	MAR-463
JS 2—Check Gas Oven Temperature for Proper Oven Thermostat Settings.....	MAR-467
JS 3—Recalibrate a Gas Oven Thermostat to Correct Settings.....	MAR-469
JS 4—Remove, Disassemble, Clean, Lubricate, and Reassemble a Standard Gas Burner Valve.....	MAR-481

Gas Ranges and Ovens Unit 12

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction or individual learning activities. Study the specific objectives to determine the order in which you will present the objectives.
2. Review Teaching Suggestions section that follows. Plan for classroom activities.
3. Plan enrichment of exceptional students as well as accommodation of special needs students.
4. Add overheads or other graphic materials as desired to enhance instruction, and reinforce noted objectives with the following transparencies:

TM 1—Types and Characteristics of Gases (Objectives 2 and 3)
TM 2—Nameplate Information (Objective 4)
TM 3—Top Burner Operation (Objective 4)
TM 4—Burner Types (Objective 4)
TM 5—Automatic Oven Ignition System (Objective 10)
TM 6—Semi-Automatic Oven Ignition System (Objective 10)
TM 7—Manual Oven Ignition System (Objective 10)
TM 8—Hydraulic Thermostat (Objective 12)
TM 9—Electric-Hydraulic Thermostat (Objective 12)
TM 10—Pneumatic Thermostat (Objective 12)
TM 11—Circuit Operations During Bake Operation (Objectives 21 and 22)
TM 12—Circuit Operations During a Timed Bake Operation (Objectives 21 and 22)
TM 13—Circuit Operations During a Clean Operation (Objectives 21 and 22)
TM 14—Circuit Operations During Lock and Unlock Operations (Objectives 21 and 22)
TM 15—Manometer Pressure Equivalent Table (Objective 25)

5. Develop teaching plan. Adjust for different learning styles.
6. Make copy of the Unit Evaluation Form for each student.

Delivery and Application

7. Provide students with unit of instruction.
8. Discuss unit and specific objectives.
9. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic skills when applicable.
10. Discuss and demonstrate, as necessary, activities in the assignment and job sheets. Review criteria for evaluating these activities.

Suggested Activities

Evaluation

11. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.
12. Make copies of written test. Add or modify test items as needed.
13. Give written test.
14. Compile assignment sheet and job sheet ratings and written test scores on the Unit Evaluation Form. Include any additional assignment or job sheets added to the unit.
15. Reteach and retest as required.

Teaching Suggestions

Note: Skill areas appearing in boldface type in the Teaching Suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: a SCANS Report for America 2000*. These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

1. Have individual components from gas ranges and ovens available for demonstration as you discuss those items in the information sheet. **Basic skills, science and listening.**
2. As you discuss the wiring schematics in the assignment sheets, demonstrate the use of a VOM for circuit analysis. Impress upon students the use of appropriate test instruments for troubleshooting major appliances. **Basic skills, science and listening.**
3. Invite a representative of a local gas utility company to talk to the class about how gas supplies in the area are generated, how gas usage is priced, and the importance of safety around all gas appliances, especially in hook-up, service, and repair. Also have a gas company representative demonstrate how a manometer is used to check gas pressure. **Basic skills, science and listening.**

Suggested Activities

Resources Used in Developing This Unit

1. Anderson, Edwin P. *Home Appliance Servicing*. Indianapolis, IN: Howard W. Sams and Company, Inc., 1974.
2. Bacon, Bill and Mark Sutton. *Major Appliance Repair*. Austin, TX: The University of Texas of Austin, 1983.
3. *Cooking Equipment Course*. Chicago, IL: Sears Training Center, n.d.

Suggested Supplemental Resources

1. Frigidaire service literature for gas ranges and ovens is available from:

Frigidaire Company
6000 Perimeter Drive
Dublin, OH 43017
614-764-8640

2. GE service literature for gas ranges and ovens is available from:

Dri-View Mfg. Co.
4706 Allmond Ave.
Louisville, KY 40209
or from GE Parts at 1-800-626-2002

3. Maytag and Norge service literature for gas ranges and ovens is available from:

Maytag Customer Service
Maytag Appliances
240 Edwards Street, S. E.
Cleveland, TN 37311
423-478-6788

Suggested Activities

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

- 4 Skilled—Can perform job with no additional training.
- 3 Moderately skilled—Has performed job during training program; limited additional training may be required.
- 2 Limited skill—Has performed job during training program; additional training is required to develop skill.
- 1 Unskilled—is familiar with process, but is unable to perform job.

Option B

- Yes—Can perform job with no additional training.
- No—is unable to perform job satisfactorily

250

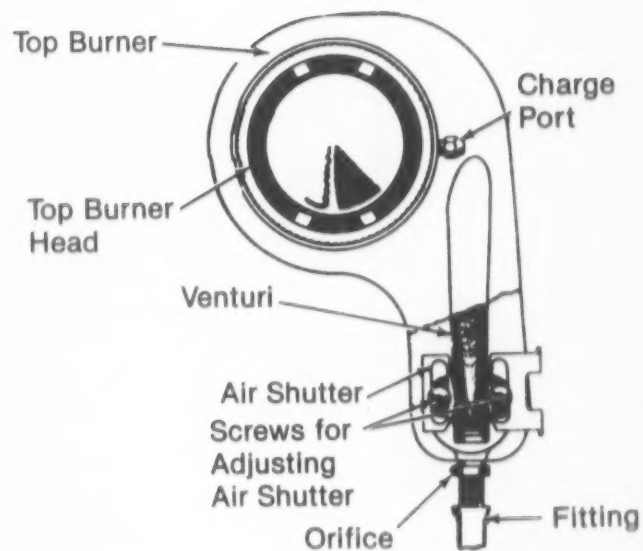
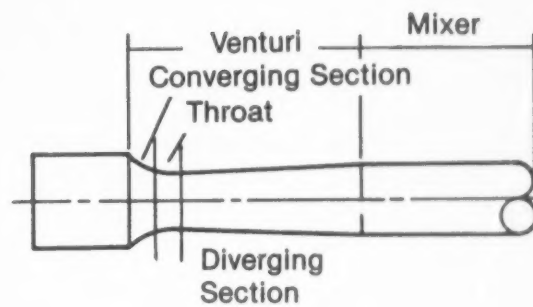
Types and Characteristics of Gases

	TYPE OF GAS				
	Manufactured	Natural	Mixed	Propane	Butane
Specific Gravity (Air = 1)	0.40-0.70	0.60-0.70	0.60	1.52	2.00
Heating Value, Btu/cu.ft.	520-600	925-1200	800	2570	3260
Explosive Limits, % Gas in Air					
Lower	5.6	4.8		2.4	1.9
Upper	31.7	14.0		9.5	8.4
Main Constituents, %					
Hydrogen	50		25		
Carbon Monoxide	10		5		
Methane	25	90	60		
Ethane		5	3	3	
Propane				97	6
Butane					94
Cu. Ft. of air required for complete combustion of one cu.ft. of gas	5	10	8	24	31

Nameplate Information

HOURLY B.T.U. RATINGS FOR NATURAL, MANUFACTURED, MIXED AND L.P. GAS: OVEN RANGE TOP ROTISS		IN ALL CORRESPONDENCE REGARDING THIS ARTICLE MENTION THIS KENMORE MODEL NO. REG. TRADE MARK	
23,000	8,000 EACH		
HOURLY B.T.U. RATINGS FOR NATURAL, MANUFACTURED OR MIXED GAS: RIGHT AND LEFT REAR TOP BURNER RIGHT AND LEFT FRONT TOP BURNER		THIS RANGE IS SHIPPED FROM THE FACTORY EQUIPPED FOR USE WITH L.P. GAS (BOTTLED OR TANK GAS). ALL ORIFICE HOODS MUST BE LEFT SCREWED TIGHT WHEN L.P. GAS IS USED.	
9,000	12,000	THIS RANGE CAN ALSO BE USED WITH NATURAL OR MIXED GAS AFTER THE FOLLOWING ADJUSTMENTS ARE MADE:	
GRIDDLE		1. MAIN BURNER ORIFICE HOODS: UNSCREW HOODS UNTIL SPECIFIED INPUT RATE TO EACH BURNER IS OBTAINED.	
12,000		2. ON RANGES WITH SIDE TOWER BURNER, REMOVE THE BRASS TOWER BURNER SPUD AND REPLACE WITH A NICKEL SPUD WHICH MAY BE FOUND BEHIND THIS PLATE.	
HOURLY B.T.U. RATINGS FOR L.P. GAS: RIGHT AND LEFT REAR TOP BURNER RIGHT AND LEFT FRONT TOP BURNER		3. ON RANGES WITH LO-TEMP OVEN, REMOVE THE RED HEATER PILOT ORIFICE AND REPLACE WITH A BLACK ORIFICE WHICH MAY BE FOUND BEHIND THIS PLATE.	
8,000	10,000	THIS RANGE CAN ALSO BE USED WITH MANUFACTURED GAS BY INSTALLING CONVERSION PARTS (WHICH MAY BE ORDERED THROUGH SEARS, ROEBUCK AND CO.'S MAIL ORDER HOUSES OR RETAIL STORED).	
GRIDDLE		ANY INFORMATION ON THIS PLATE REFERRING TO EQUIPMENT NOT FOUND ON YOUR RANGE MAY BE DISREGARDED	
10,000		FLUSH TO WALL	
MINIMUM HORIZONTAL DISTANCE FROM SIDES OF RANGE TO ADJACENT COMBUSTIBLE VERTICAL SURFACES EXTENDING ABOVE COOK TOP:			
4"			
115 AMPS	60 CYCLES	15 AMPS	
SERIAL NO.			
MANUFACTURED IN U.S.A. FOR SEARS, ROEBUCK AND CO., U.S.A. ORDER REPLACEMENT PARTS THRU ANY OF OUR MAIL ORDER HOUSES OR RETAIL STORES			
COVERED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS:			
2,490,885 2,787,948 2,524,210 2,862,667 2,560,777 RE. 23,299 OTHER PATENTS PENDING			

Top Burner Operation



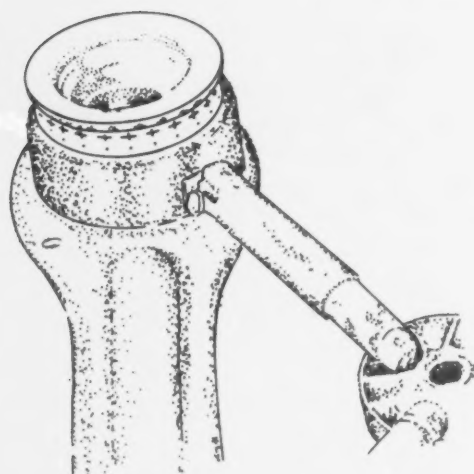
Courtesy Sears

263

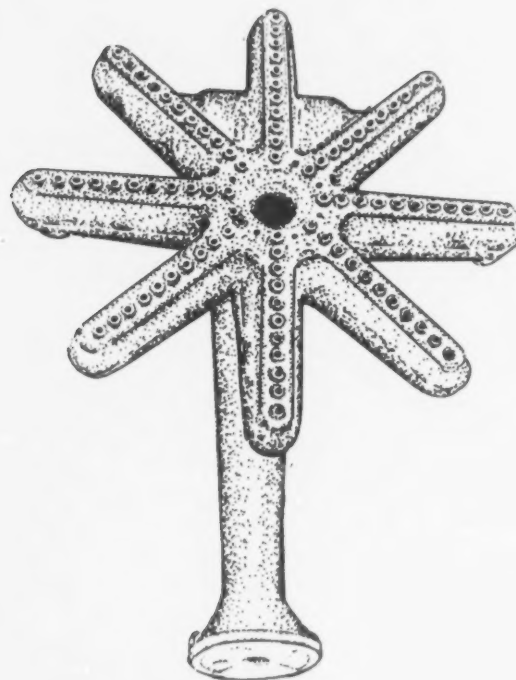
Major Appliance Repair, Unit 12
Teacher Page 9

TM 3

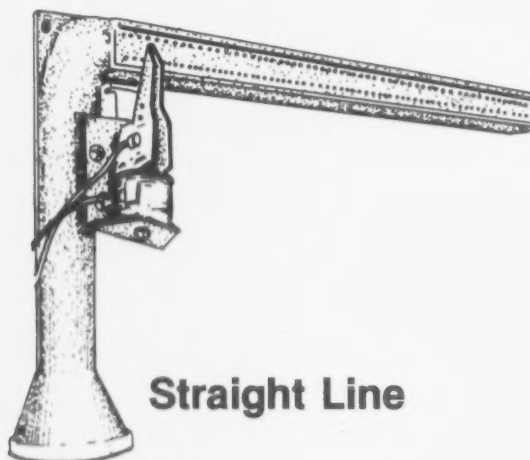
Burner Types



Circular



Star

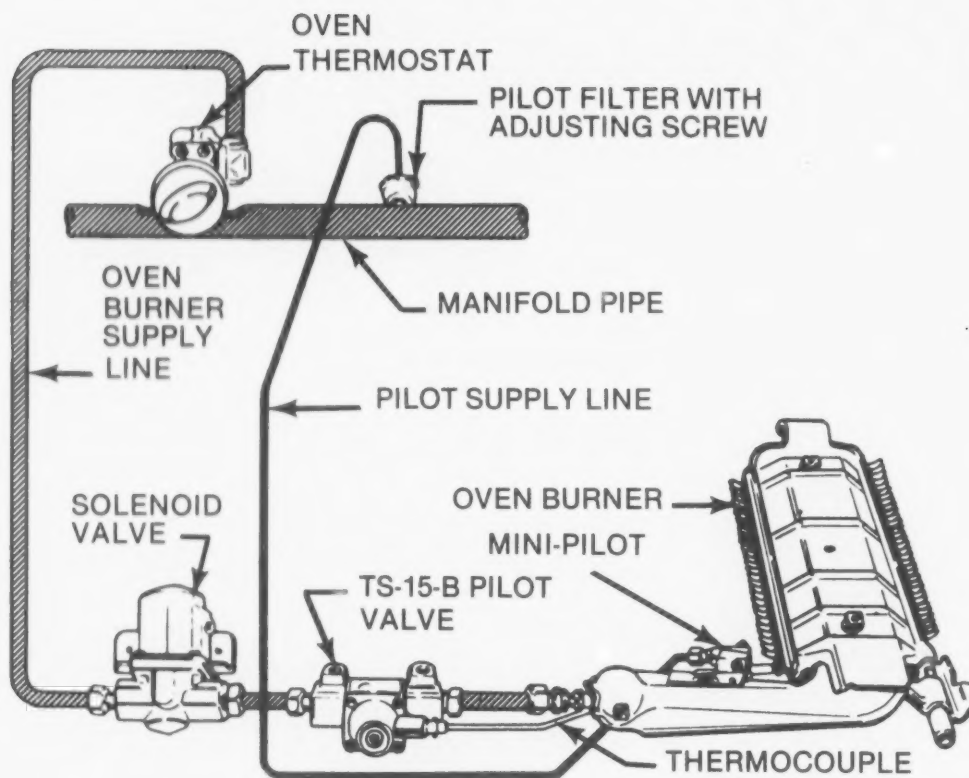


Straight Line

264

TM 4

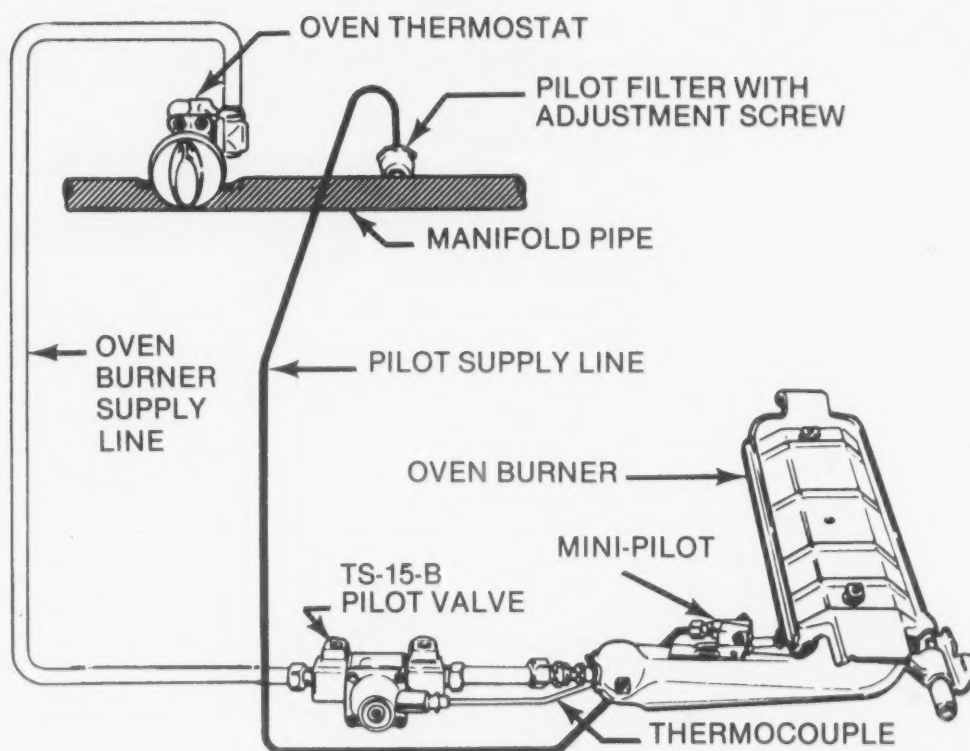
Automatic Oven Ignition System



265

TM 5

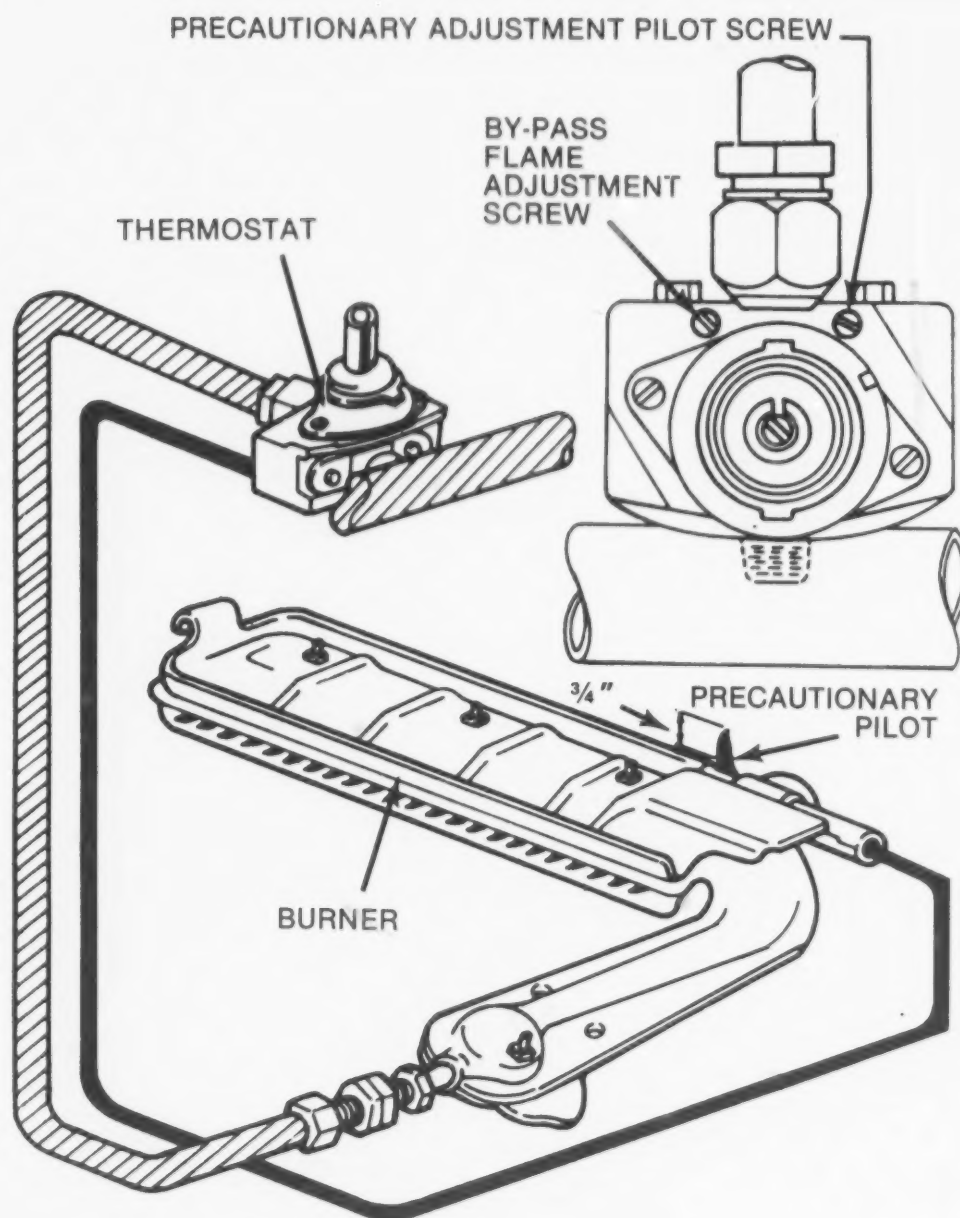
Semi-Automatic Oven Ignition System



266

TM 6

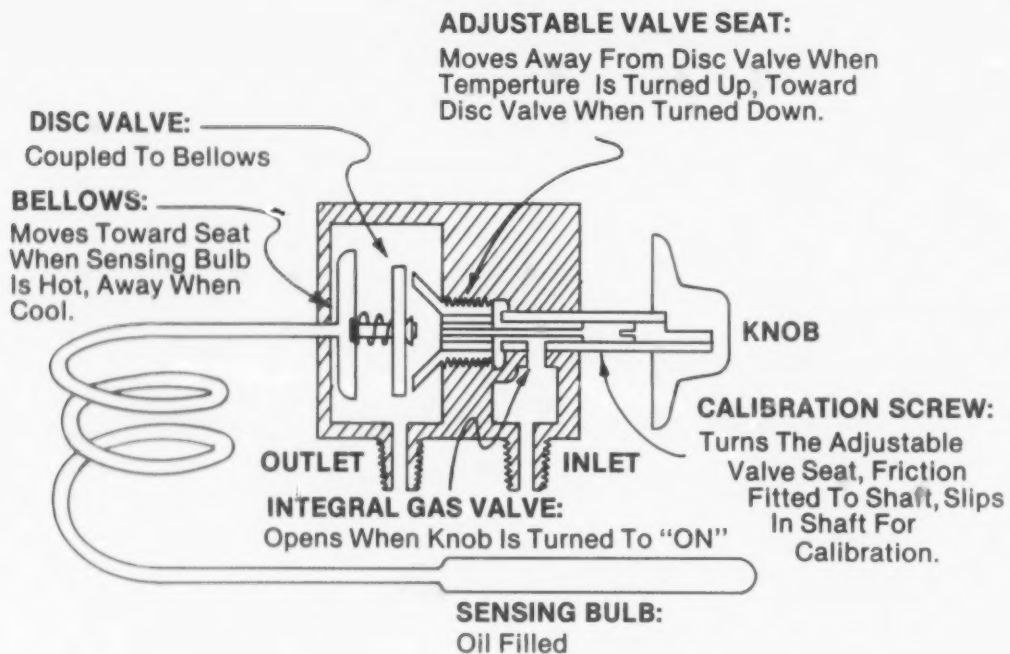
Manual Oven Ignition System



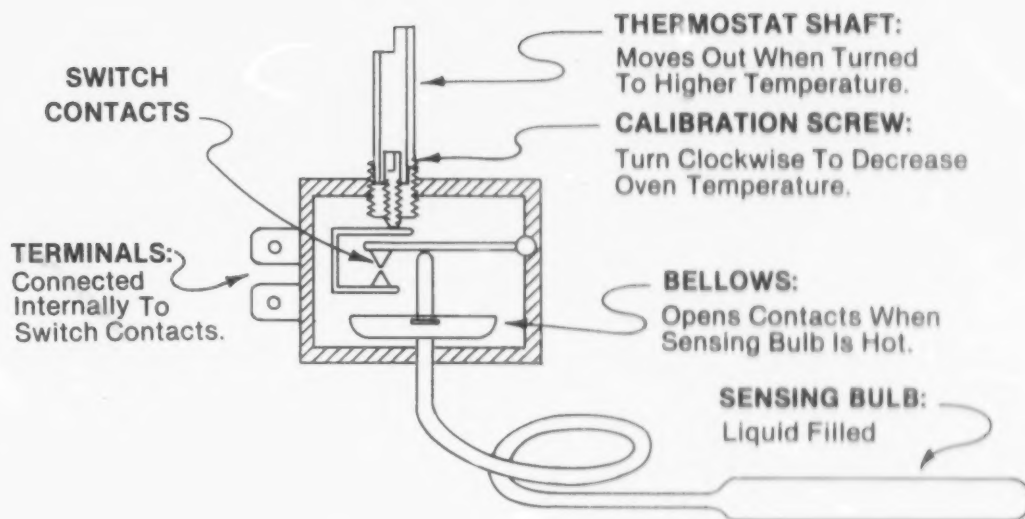
267

TM 7

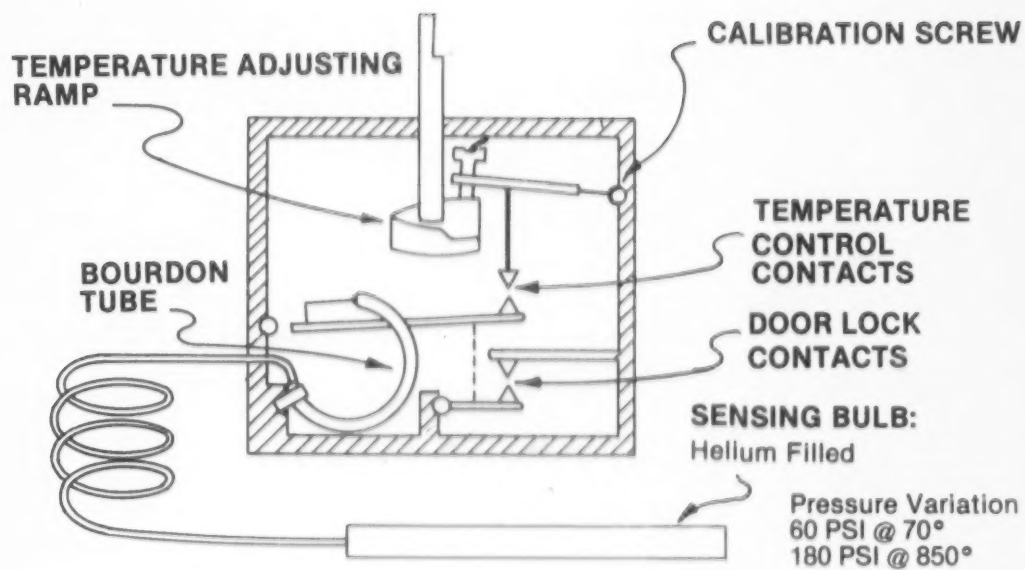
Hydraulic Thermostat



Electric-Hydraulic Thermostat

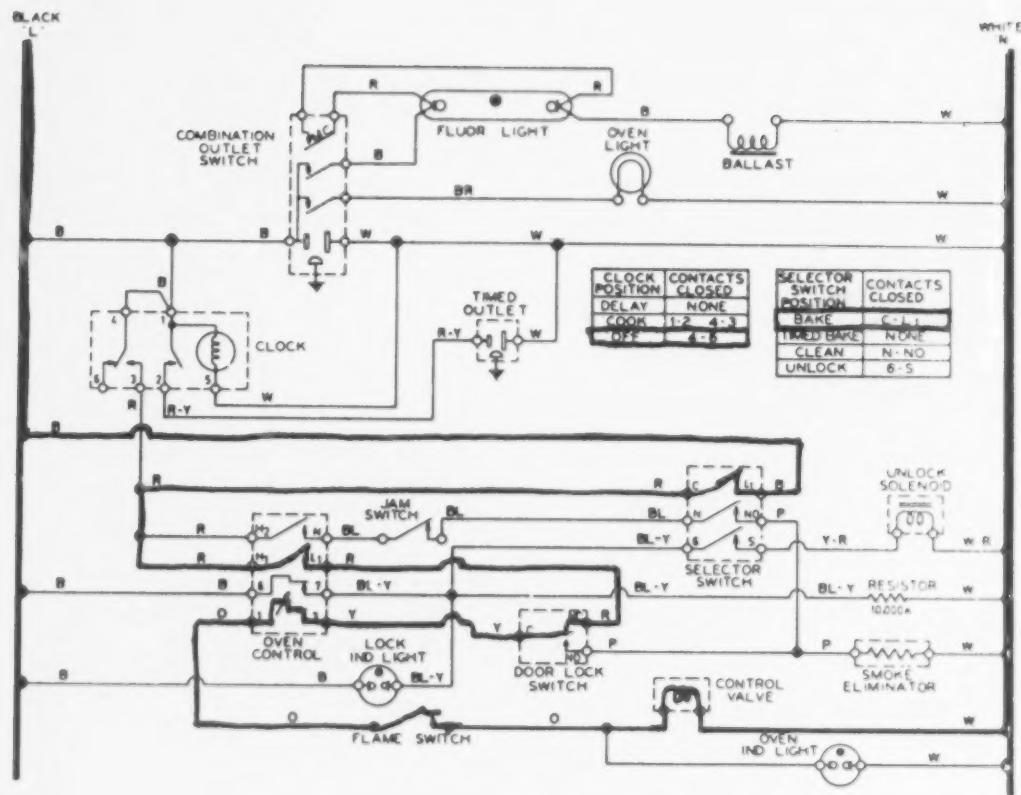


Pneumatic Thermostat



Circuit Operations During a Bake Operation

(Self-Cleaning Gas Oven)



Courtesy Sears

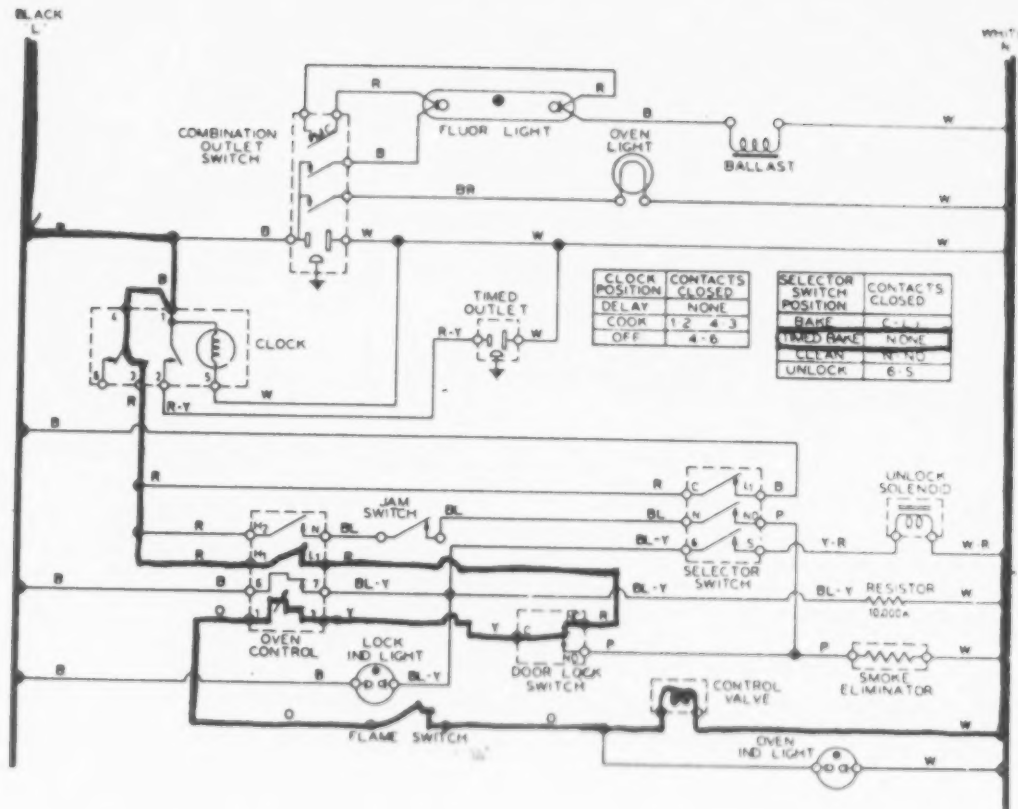
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271

TM 11

Circuit Operations During a Timed Bake Operation

(Self-Cleaning Gas Oven)



Courtesy Sears

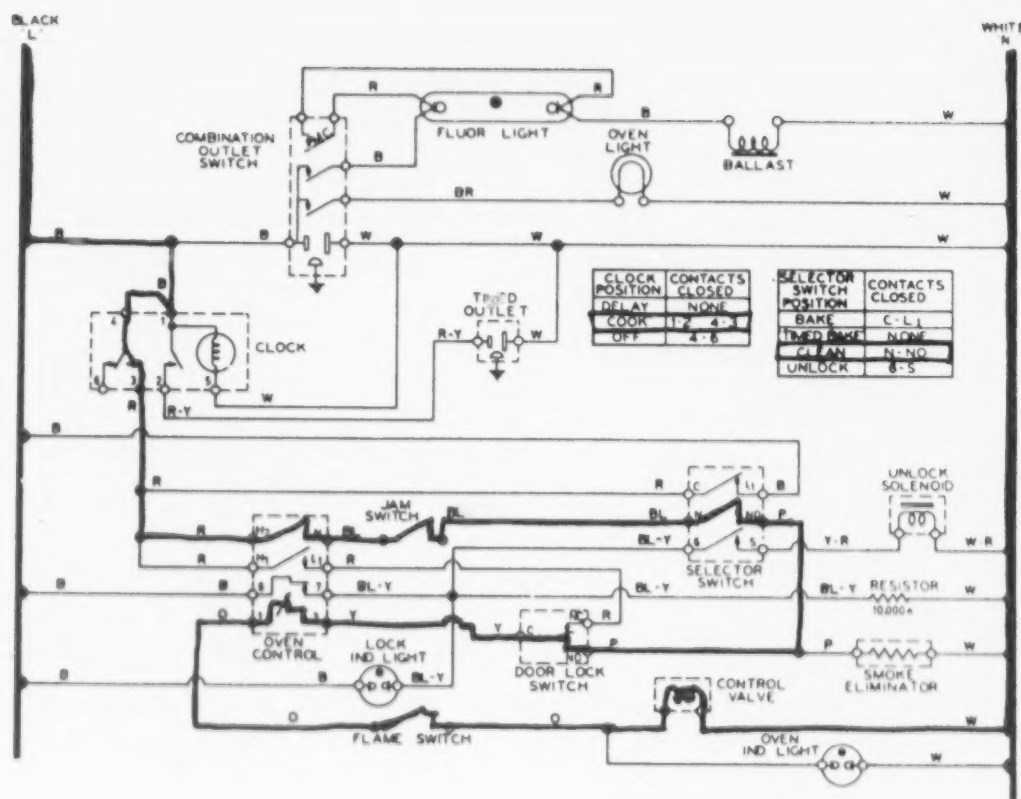
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272

TM 12

Circuit Operations During a Clean Operation

(Self-Cleaning Gas Oven)



Courtesy Sears

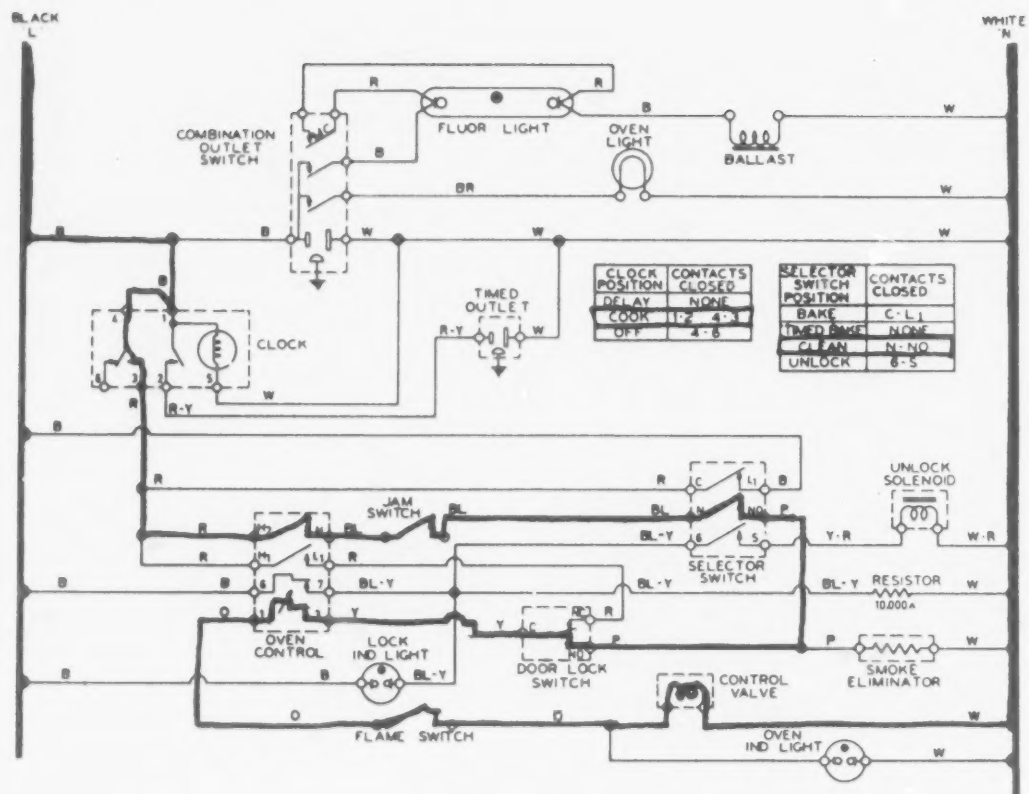
273

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TM 13

Circuit Operations During Lock and Unlock Operations

(Self-Cleaning Gas Oven)



Courtesy Sears

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274

TM 14

Manometer Pressure Equivalent Table

INCHES OF WATER	INCHES OF MERCURY	OUNCES PER SQ. IN.	POUNDS PER SQ. IN.
.5	0.037	0.289	.0181
1	0.074	0.578	.0361
2	0.148	1.156	.0723
3	0.222	1.734	.1084
4	0.296	2.312	.1445
5	0.370	2.890	.1807
6	0.454	3.468	.2168
7	0.518	4.046	.2529
8	0.592	4.624	.2890
9	0.666	5.202	.3252
10	0.740	5.780	.3613
11	0.814	6.358	.3974
12	0.888	6.936	.4336
13	0.962	7.514	.4697
14	1.036	8.092	.5058
15	1.110	8.670	.5420
16	1.184	9.246	.5781
17	1.258	9.826	.6142
18	1.332	10.404	.6503
19	1.406	10.982	.6865
20	1.480	11.560	.7226
21	1.554	12.138	.7587
22	1.628	12.716	.7949
23	1.702	13.294	.8310
24	1.776	13.872	.8671
25	1.850	14.450	.9032
26	1.924	15.028	.9394
27	1.998	15.606	.9755
28	2.072	16.184	1.0116

**Gas Ranges and Ovens
Unit 12**

Answers to Assignment Sheets

Assignment Sheet 1

- A. 120 volts
- B. 0 volts
- C. 0 volts
- D. 120 volts
- E. 10,000 volts
- F. 0 Ω

Assignment Sheet 2

- A. 120 volts
- B. 0 volts
- C. 120 volts
- D. 0 Ω
- E. About 100 Ω

Assignment Sheet 3

- A. 120 volts
- B. 120 volts
- C. About 120 volts
- D. About 600 Ω
- E. About 150 Ω

Assignment Sheet 4

- A. 120 volts
- B. 0 volts
- C. 0 Ω
- D. 0 to 5 Ω

276

Gas Ranges and Ovens
Unit 12

Written Test

Name _____ Date _____ Score _____

1. Match each term on the right with its correct definition.

- | | | | |
|----------|--|-----|---------------|
| _____ a. | National organization that sets design and performance standards for gas appliances, and conducts laboratory and on-site checks for compliance | 1. | LP gas |
| _____ b. | A metal sheet (flat or slightly V-shaped) placed over an oven burner to divert heat to both sides of a gas oven and keep direct flame off the oven bottom to prevent burnout | 2. | Manometer |
| _____ c. | Valves that screw into a gas manifold to control gas flow to the top burners | 3. | Charge port |
| _____ d. | A small fitting mounted on the side of a burner where it directs gas through a flash tube to a pilot light causing the burner to ignite | 4. | Venturi |
| _____ e. | Controls gas pressure flow into the manifold and other gas range components | 5. | AGA |
| _____ f. | A general reference to both propane and butane gases used for heating and cooling purposes when natural gas is unavailable | 6. | Thermostat |
| _____ g. | A pipe which receives gas from the gas supply and distributes that gas to the burner valves and the oven thermostat on a gas range | 7. | Baffle |
| _____ h. | An instrument, usually a U-shaped glass tube, for measuring the pressure of gases or vapors | 8. | Manifold |
| _____ i. | A device mounted on a manifold to control gas flow to an oven much like burner valves control gas flow to top burners on a gas range | 9. | Burner valves |
| _____ j. | Tube-like connection where air and gas are mixed and transported to a top burner on a gas range | 10. | Gas regulator |

Written Test

2. Complete statements about the basics of gas heating. Insert the word(s) or figure(s) that best completes each of the following statements.
- a. Gas heating and cooking devices are rated according to a unit of _____ known as a BTU.
 - b. A BTU is equal to the amount of heat required to raise one pound of _____ one degree Fahrenheit.
 - c. Gases are rated in BTU's.
 - (1) _____ gas may range from 300 to 3,000 BTU per cubic foot.
 - (2) The standard for natural gas in America is almost always _____ BTU per cubic foot, and most heating and cooking appliances are designed with that standard in mind.
 - (3) A gas range should list the BTU rating of every burner and the _____ on the name plate.
 - d. Gas burners are designed according to their intended use.
 - (1) A standard size surface burner for _____ use is usually rated about 9,000 BTU/hr.
 - (2) A jumbo size burner for _____ use is usually rated about 12,000 BTU/hr.
 - (3) Oven burners for _____ use are usually rated about 23,000 BTU/hr.
 - e. Burner ratings should never be _____.
3. Select true statements about natural and bottled gas. Place an "X" beside each true statement.
- _____ a. Natural gas comes from wells and is usually piped from a central supply point to homes and businesses in an area.
 - _____ b. Propane and butane are extracts from crude petroleum and are stored in bottles and tanks as a liquid, and then changed to gas when they are used.
 - _____ c. Because of its convenience, natural gas is the most common gas used for gas appliances, but in areas remote from a central natural gas supply, propane and butane are used.

Written Test

- _____d. Natural gas is heavier than air and will collect in low spots, but propane and butane are lighter than air and will rise in the atmosphere.
- _____e. Natural gas, propane, and butane are all odorless and colorless and have mercaptan added to them to provide color and a pungent odor so leaking gas can be quickly detected.
4. Complete statements about how a gas range top burner works. Insert the word(s) that best completes each of the following statements.
- a. The main gas supply goes through a gas regulator valve which assures gas will be delivered to the range at a _____ proper pressure.
- b. The gas regulator valve feeds gas into a _____ which serves as a gas transmission line to the top burners, oven pilot, and oven burner.
- c. For a top burner, a gas control valve is screwed into the _____ so that it can be manually operated to turn gas on or off.
- d. From the gas control valve, gas goes through a spud which is screwed into the valve, and from the spud through an _____ with a hood that holds it in place.
- e. Gas from the _____ is fed into a venturi where an air shutter allows air in to mix with the gas.
- f. As gas is mixing in the venturi and being carried to the burner, another constant gas flow is going down a separate tube to the _____.
- g. As gas from the venturi reaches the burner, part of it passes out a flash port on the side of the burner, and is directed down a flash tube to the _____ flame.
- h. As the _____ flame ignites gas from the flash port, gas at the burner itself is ignited, combustion is complete, and burning begins.
5. Select true statements about orifice settings. Place an "X" beside each true statement.
- _____a. A range will come from the manufacturer with the orifice preset for natural gas.
- _____b. An orifice for LP gas can be used with natural gas because the opening is the same.
- _____c. If the orifice in the range is improper for the local gas supply it must be replaced with the proper orifice.
- _____d. If the orifice is a universal orifice, it cannot be adjusted for LP gas.

Written Test

- _____e. The universal orifice can be adjusted for natural gas by screwing the orifice hood out to achieve proper flame size.
- _____f. If the needle is solid, no hole in the center, the orifice opening can only be adjusted by changing to another hood with an opening sized either for LP gas or natural gas.
- _____g. When connecting the hood to a venturi, it may be necessary to use an extension called an extender to reach into the venturi the proper distance.
6. Select true statements about primary and secondary air. Place an "X" beside each true statement.
- _____a. Primary air enters the gas supply through an air shutter located at the front of the venturi.
- _____b. Primary air is mixed with gas in the throat of the venturi and enters the burner combustion area as an air/gas mixture which is ignited.
- _____c. Secondary air comes from the entire area around the burner and mixes with the flame as it comes from the burner.
- _____d. Secondary air stabilizes the flame, completes combustion, and carries off the byproducts of combustion.
7. Complete statements about byproducts of combustion. Circle the word(s) that best completes each of the following statements.
- a. When gas burns it gives off **(water) (gas)** vapor which is usually absorbed by the atmosphere around the range area.
- b. When a home or kitchen area is improperly ventilated, **(water vapor) (soot)** may condense on walls or other surfaces.
- c. Improper combustion that leaves part of the gas unburned will produce CO which is **(mild) (extremely)** dangerous to humans.
- d. Although CO is odorless and colorless, it can usually be quickly detected because it is accompanied by other gases called **(aldehydes) (sulfides)** which do have a pungent odor and irritate the nose and eyes.
- e. When there is an indication that **(water vapor) (CO)** is present, the appliance should be shut down and not used until it has been properly adjusted.

Written Test

8. Recommend solutions for the following burner combustion problems.

a. The problem: Flame is literally leaping off the burner

Solution: _____

b. The problem: Flame burns yellow and produces soot

Solution: _____

c. The problem: Flame looks lazy and seems to float away from the burner

Solution: _____

9. Complete the following chart of gas burner types and applications. Fill the blanks with the appropriate information.

Type of Burner	Shape	Application	Performance
Drilled-Ring	a. _____	Top surface burners	Is most efficient burner because it provides a better supply of secondary air to all parts of the flame
Drilled-Pipe	Star	b. _____	Permits more drilled holes to provide better heat distribution and greater capacity for large pots and pans used commercially
c. _____	Oval, straight line, or special configuration	Ovens, trays, tanks, and special application	Permits even distribution of heat over surfaces of large oven, tray, or tank areas in cases where circular or star burners could heat only a part of the surface

Written Test

10. Match types of oven ignition systems with their characteristics.

- | | | |
|---------|--|----------------------------|
| _____a. | (1) most popular type, | 1. Manual ignition |
| | (2) has no standing pilot, | 2. Automatic ignition |
| | (3) goes through ignition process each time the oven calls for heat, and | 3. Semi-automatic ignition |
| | (4) may use sparking points, a glow coil, or a silicon carbide coil for ignitions. | |
| _____b. | (1) gas supply controlled by a thermostat in the manifold, | |
| | (2) uses same gas regulator and manifold as top burners, | |
| | (3) as gas reaches the oven burner, it is ignited by a standing pilot, | |
| | (4) a thermostat senses ambient temperature in the oven and shuts off gas supply when oven heats to a specified temperature, and | |
| | (5) thermostat also turns gas supply back on when oven cools below specified temperature. | |
| _____c. | (1) gas enters oven burner when thermostat is turned on, | |
| | (2) burner must be lit with a match placed at the entrance to a flash tube, | |
| | (3) precautionary pilot comes on only after oven burner has ignited, | |

282

Written Test

- (4) thermostat bypasses enough gas to maintain a minimum flame,
 - (5) precautionary pilot goes out when the thermostat is turned off,
 - (6) oven must be manually lit each time it is used, and
 - (7) these type ovens are no longer manufactured, but some are still around.
11. Complete statements about how a gas oven works. Insert the word(s) that best completes each of the following statements.
- a. After the oven burner is ignited, heat from the burner enters the oven cavity through a row of _____ along each side of the oven bottom.
 - b. _____ circulates through the oven and around food placed into the oven.
 - c. There are byproducts of combustion that are carried along with the hot circulating air out of the oven and into the oven _____.
 - d. Hot air also circulates around the thermostat capillary tube so oven temperature can be _____.
 - e. Oven may be shut off _____ or shut off by a timer control or a temperature-probe control.

Written Test

12. Match types of oven thermostats with their characteristics.

- | | | |
|---------|--|----------------------------------|
| _____a. | (1) usually filled with oil, | 1. Electric hydraulic thermostat |
| | (2) as oil is heated or cooled it activates or deactivates a bellows, and | 2. Pneumatic thermostat |
| | (3) the bellows move or close a disc valve to start or stop gas flow. | 3. Hydraulic thermostat |
| _____b. | (1) used only in electrically controlled gas ranges or in electric ranges, | |
| | (2) uses a liquid filled sensing bulb to activate or deactivate a bellows, and | |
| | (3) instead of moving a disc valve, the bellows opens or closes a set of contact switches to start or stop gas flow. | |
| _____c. | (1) used in self-cleaning gas ovens because a thermostat with liquid in the design would not operate at the 850° to 900° temperatures needed to clean an oven, | |
| | (2) works with a C-shaped bourdon tube, a thermostat tube, and a sensing bulb all filled with helium, | |
| | (3) heat creates vapor pressure which causes the bourdon tube to straighten out, | |
| | (4) cooling causes the bourdon tube to return to its original position, | |

Written Test

- (5) the action of the bourdon tube controls the temperature control contacts to keep the burner cycling on and off as needed, and
 - (6) the action of the bourdon tube also controls the door lock contacts so the oven door is locked shut during the self-clean cycle.
13. Complete statements about safety valves. Circle the word(s) that best completes each of the following statements.
- a. Safety valves on gas ranges serve two valuable safety purposes:
 - (1) gas from the main gas supply **(will) (will not)** flow if the pilot light is out when the gas is turned on.
 - (2) gas from the main gas supply will be shut off if the **(pilot goes out) (gas pressure decreases)** while the oven is in operation.
 - b. One common safety valve works with a mercury sensing bulb that has to be heated by the oven **(pilot) (thermostat)** before it will open, and will close immediately if the **(thermostat) (pilot)** goes out.
 - c. Another type safety valve uses a bi-metal actuating device with a wrap-around heater, and this valve works in conjunction with a **(flame switch) (thermostat)** which senses whether the pilot is lit or not lit.
14. Complete statements about common misuses of as ovens. Insert the word(s) that best completes each of the following statements.
- a. Covering the _____ at the bottom of the oven will cause baking problems and damage the oven.
 - b. Using large pieces of _____ to catch spills will literally divide the oven into improperly heated parts and cause baking problems.
 - c. Placing _____ too close to the oven wall will also impair circulation and jamming too many pans on one shelf will impair circulation.

Written Test

15. Select true statements about special considerations for ovens with upper and lower burners. Place an "X" beside each true statement.
- ☐ a. In a two-burner oven, the upper burner pilot requires a separate fresh air supply because the upper pilot cannot burn in the byproducts of combustion from the lower burner.
 - ☐ b. To assure the upper burner pilot will have a proper fresh air supply requires a separate tube to bring fresh air to the upper pilot.
 - ☐ c. Fresh air supply to an upper burner is usually accomplished with a snorkle-like tube that brings fresh air from outside the oven and serves no other function.
16. Complete statements about how self-cleaning ovens work. Circle the word(s) that best completes each of the following statements.
- a. Most oven spills are forms of **(calcium) (hydrocarbons)** that break down into water and gases when burned in a temperature above 850°F.
 - b. The intense heat causes a decomposition process called **(thermalysis) (pyrolysis)** and leaves a white ash that can be easily wiped off.
 - c. In most gas ovens, smoke and other byproducts of self-cleaning are directed out of the oven **(flue) (side panel)**.
17. Select true statements about special safety features of self-cleaning ovens. Place an "X" beside each true statement.
- ☐ a. Since the high temperatures in the self-cleaning function pose a fire danger and danger to the operator, special safety features are built into self-cleaning ovens.
 - ☐ b. A metal-mesh protection screen must be manually pulled into place over the glass in the oven door before the oven door can be manually latched for self-cleaning.
 - ☐ c. As another safety feature, an inside thermometer activates an inside door lock when the oven reaches 550°F.
 - ☐ d. The inside door latch stays in place until the oven cools back down to less than 800°F.

Written Test

18. Complete a list of safety requirements for gases. Insert the word(s) that best completes each of the following statements.
- a. Be sure to shut off all gas appliances before turning off the _____ gas supply.
 - b. _____ while working around gas appliances is ABSOLUTELY FORBIDDEN.
 - c. Never use a _____ or any open flame to test for gas leaks.
 - d. Test for leaks by brushing on a soap-water mixture and watching for _____ which would indicate a leak.
 - e. Use pipe dope, Teflon tape, or Teflon dope when making up connections on supply lines that are made of _____.
 - f. Do not use pipe dope on any _____ fitting except when mating a _____ fitting to a steel supply line.
 - g. Propane and butane will _____ some pipe dope, so be sure you use dope that is LP gas resistant.
 - h. Do not expose your bare hands or skin to propane or butane because they absorb heat so fast that escaping gas can cause _____.
 - i. Keep propane and butane tanks away from _____ heat.
 - j. Never fill a propane or butane tank completely full because both gases require _____ space.
 - k. Never use _____ gaskets or washers around propane or butane because both gases will dissolve _____.
19. Complete statements about flexible connectors. Insert the word(s) that best completes each of the following statements.
- a. Flexible connectors make hooking up a range much easier, but be sure _____ permit the use of flexible connectors before installing one.
 - b. Bend or shape flexible connectors with care because they are made of _____ and are fairly easy to break.
 - c. _____ flexible connectors are preferred because bare copper connectors readily corrode in situations where propellants from canned aerosol cooking aids can reach them.

Written Test

- d. Use no pipe dope on _____ fittings except the connector fitting from a steel pipe inlet.
 - e. Use only connectors that have dielectric qualities and the _____ seal of approval that indicates the connector meets _____ requirements.
 - f. Limit flexible connections to no more than _____ feet.
 - g. Make sure the connector is properly sized to _____ the gas branch line to which it is connected.
20. Select true statements about requirements for gas supply lines. Place an "X" beside each true statement.
- _____ a. Most incoming gas supply lines have a diameter of 1".
 - _____ b. Most feeder lines off the main gas supply lines have a diameter of 3/4".
 - _____ c. Piping used for gas transport must be made only of black iron.
 - _____ d. Pipe dope, Teflon dope, or Teflon tape should be used when making up all joints and connections on black iron or galvanized iron.
21. Complete statements about functions of electrical circuits on gas ovens. Insert the word(s) that best completes each of the following statements.
- a. Electrical circuits on self-cleaning gas ovens operate oven lights, clocks, and _____ devices.
 - b. Electrical circuits on gas ovens also operate the door lock switch and other elements of the _____ function.
22. Solve the following problems about typical circuit functions in a gas oven.
- a. In a simple BAKE function, how is oven burner operation controlled?
Answer _____
 - b. What controls the length of a TIMED BAKE function?
Answer _____
 - c. What controls temperatures in the CLEAN operation of a self-cleaning oven?
Answer _____

Written Test

23. Match gas range complaints with recommended troubleshooting.

- | | | |
|---------|--|---|
| _____a. | <ul style="list-style-type: none"> (1) poorly adjusted pilot light, (2) poorly adjusted burner flame so high that it puts the pilot out, or (3) bad safety valve or thermocouple. | <ul style="list-style-type: none"> 1. When the flame jumps off the burner or the flame is smoky, check for: |
| _____b. | <ul style="list-style-type: none"> (1) top burner pilot light out, (2) flash tube to pilot clogged or out of position, (3) burner itself out of position, (4) flash port clogged, (5) burner itself clogged, (6) improper primary air, or (7) wrong size orifice. | <ul style="list-style-type: none"> 2. When the oven is sweating, check for: 3. When the pilot light is out and will not light or will not stay lit, check for: 4. When there is an odor of gas around the range, check for: 5. When the oven is not heating properly, check for: 6. When the top burner will not light or the flame is too high or too low, check for: |
| _____c. | <ul style="list-style-type: none"> (1) too much primary air through the shutter, or (2) too little primary air through the shutter. | |
| _____d. | <ul style="list-style-type: none"> (1) oven thermostat problems, (2) bypass gas supply problems, (3) improper calibration of oven thermostat, (4) improper burner adjustment, or (5) improper gas pressure. | |
| _____e. | <ul style="list-style-type: none"> (1) improper preheating, (2) oven thermostat temperatures incorrect, or (3) clogged oven vent. | |
| _____f. | <ul style="list-style-type: none"> (1) gas leak in connections along supply lines, (2) oven burners not getting enough primary air, or (3) oven pilot touching burner. | |

280

Written Test

24. Select true statements about gas pressure drops. Place and "X" beside each true statement.

Note: For a statement to be true, all parts of the statement must be true.

- ____ a. No gas appliance will operate properly at a gas pressure less than the appliance is rated for.
- ____ b. Gas ranges have gas pressure ratings expressed in ounces of gas pressure per square inch.
- ____ c. An average gas rating for natural gas is 4 oz. PSI, and for LP gas, 10 oz. PSI.
- ____ d. With natural gas, a pressure drop can be regulated at the meter, but with an LP gas pressure drop, the adjustment has to be made at the appliance.
- ____ e. The two most common causes of pressure drops are:
 - (1) an obstruction in the main gas supply line, usually water, or
 - (2) undersized piping that will not serve multi-appliance demands.
- ____ f. Water problems are frequent with gas lines in high-acidity soils because acid attacks and corrodes the iron pipe.
- ____ g. pilot lights that keep going out, and erratic burner operation are signs of water problems.
- ____ h. In situations where several gas appliances are in use at one time, undersized piping will cause pressure drop.
- ____ i. The handiest tool for troubleshooting a complaint of gas pressure drop is a pressure gauge.

25. Solve problems about manometer selection and use.

- a. When a gas pressure drop is suspected, what is the first thing to do?

Answer _____

- b. How full of water should a manometer be filled?

Answer _____

Written Test

- c. What is the advantage of working with a manometer that has a tube and does not require a special manifold fitting?

Answer _____

- d. What is a good check for undersized piping?

Answer _____

26. Complete statements about guidelines for roasting. Insert the word(s) that best completes each of the following statements.

- a. Factors that increase roasting time:

- (1) roasts that are _____ and _____ take more time to cook than standing roasts,
- (2) small roasts require more cooking time per _____ than do large roasts, and
- (3) wrapping meat or poultry in _____ increases roasting time.

- b. Factors that decrease roasting time

- (1) a thick coating of _____ decreases roasting time,
- (2) selecting _____ meat decreases roasting time,
- (3) selecting _____ roasts decreases roasting time.

- c. Using a thermometer for roasting

- (1) a thermometer should be inserted into the center of the _____ part of the meat,
- (2) the tip of the thermometer probe should not be allowed to contact areas of gristle, fat, or _____,
- (3) generally, a probe should be inserted 3 ½" into the meat, and if it is a thin roast, the probe should be inserted from an _____ that will give it a 3 ½" penetration, and
- (4) for poultry, a thermometer should be inserted into the center of the _____ above the wing or into the inside of the thigh muscle.

Written Test

27. Complete statements about guidelines for broiling. Insert the word(s) or figure(s) that best completes each of the following statements.

- a. Broiling is popular because it reduces _____ content and enhances taste.
- b. Broiling is also popular because it is about the only way to please people who like their steaks browned on the outside and _____ in the middle.
- c. Selecting steaks for broiling:
 - (1) for outside browning and a rare inside, the steak must be at least _____ thick, and it is better if it is slightly thicker.
 - (2) the steak should be kept at _____ temperature until broiling begins.
 - (3) the best way to assure the brown/rare combination is to broil a _____ steak directly from the _____.
 - (4) place the steak as close to the _____ unit as possible, and
 - (5) _____ the oven also helps to control the brown/rare combination.
- d. Ways to promote browning:
 - (1) as fat content in a steak increases, _____ increases.
 - (2) brushing any meat with _____ or _____ will increase browning.
 - (3) seasoning meats _____ broiling will increase browning because salt added prior to broiling produces moisture which delays browning, and
 - (4) handle aged steak with care because the outside cooks _____ and the inside may be too _____.

28. Complete statements about guidelines for baking. Insert the word(s) that best completes each of the following statements.

- a. Placement of shelves and pans:
 - (1) use the _____ shelf when baking on only one shelf, and space shelves so that they divide the oven in thirds when using more than one shelf.
 - (2) do not impair heat circulation by placing a pan too close to the _____ and with two or three pans, stagger them so that there is a good heat circulation around each one.

Written Test

b. Preheating:

- (1) cakes, pies, and other delicate foods require preheating, so follow the _____.
- (2) preheating is not usually required for _____ and _____.

c. Using foil:

- (1) if oven shelves are completely covered with foil, heat circulation in the oven will be _____.
- (2) foil placed directly under a pie may interfere with _____ browning.

d. Selecting pans and bakeware:

- (1) shiny _____ is best for cakes, but glass can be used if oven temperature is lowered 25 degrees.
- (2) _____ are best for pies, but dark tin or anodized aluminum can also give satisfactory results.
- (3) shiny baking sheets are best for biscuits and _____.
- (4) anodized aluminum or glass are best for _____ breads because they help make the crust thick.
- (5) a dull cookie sheet is best for _____ pies because it helps browning of the bottom crust.

29. Match baking problems with their solutions.

- | | |
|--|---|
| <p>_____ a.</p> <ol style="list-style-type: none">(1) oven flame may be too hard and primary air should be decreased.(2) baffle may be out of position or upside down, so position baffle properly.(3) flue may be blocked and it should be cleaned. | <ol style="list-style-type: none">1. When baked goods burn on one side2. When baked goods are soggy3. When baked goods crack open4. When baked goods burn on the top5. When baked good burn on the bottom |
| <p>_____ b.</p> <ol style="list-style-type: none">(1) cookware is blocking heat circulation, so position cookware away from sides of oven. | |

Written Test

- (2) pan may be unlevel or the range may be unlevel, so level the range or replace the utensil as required.
- ____c. (1) oven flame may be too soft and primary air should be increased.
- (2) baffle may be out of position or upside down, so position baffle properly.
- (3) dark cookware should be exchanged for a brighter utensil.
- (4) flue may be blocked and it should be cleaned.
- ____e. (1) oven is too hot and thermostat should be checked, or a lower temperature should be used.
- (2) batter may be improperly prepared or recipe may be wrong and require correction.
- (3) baked item may have been left in the pan too long, and it should be removed immediately.

30. Select true statements about guidelines for customer service calls. Place an "X" beside each true statement.

- ____a. Introduce yourself to the customer, identify your company, and confirm that you are there in answer to the customer's request for service.
- ____b. Ask the customer to explain the problem in his/her own words.
- ____c. Check to see if baking problems provide a clue to the trouble before looking for mechanical problems.
- ____d. Place a drop cloth around the range area before starting any work.
- ____e. Request the customer to keep the area free of children and pets.

Permission to duplicate this test is granted.

284

Gas Ranges and Ovens
Unit 12

Answers to Written Test

1.

a.	5	f.	1
b.	7	g.	8
c.	9	h.	2
d.	3	i.	6
e.	10	j.	4
2.

a.	heat
b.	water
c.	(1) natural
	(2) 1,000
	(3) oven
d.	(1) household
	(2) commercial
	(3) household
e.	surpassed
3. a, b, c, e
4.

a.	constant
b.	manifold
c.	manifold
d.	orifice
e.	orifice
f.	pilot
g.	pilot
h.	pilot
5. c, e, f
6. a, b, c, d
7.

a.	water
b.	water vapor
c.	extremely
d.	aldehydes
e.	CO
8.

a.	Too much primary air, so close the air shutter as required.
b.	Not enough primary air, so open the air shutter as required.
c.	Insufficient secondary air, so check for dirty vents or blocked flue.
9.

a.	Circular
b.	Top surface burners
c.	Drilled-Pipe

Answers to Written Test

- 10. a. 2
b. 3
c. 1
- 11. a. holes
b. hot air
c. flue
d. controlled
e. manually
- 12. a. 3
b. 1
c. 2
- 13. a. (1) will not
(2) pilot goes out
b. pilot, pilot
c. flame switch
- 14. a. holes
b. foil
c. utensils
- 15. a, b
- 16. a. hydrocarbons
b. pyrolysis
c. flue
- 17. a, b, c
- 18. a. main
b. smoking
c. match
d. bubbles
e. steel
f. brass, brass
g. dissolve
h. frostbite
i. excessive
j. expansion
k. rubber, rubber
- 19. a. local codes
b. copper
c. Plastic-coated
d. brass
e. AGA, AGA
f. six
g. match

236

Answers to Written Test

20. a, d
21. a. timing
b. self-cleaning
22. a. Through the selector switch and thermostat
b. A clock
c. The opening and closing of thermostatic contacts in the oven control
23. a. 3
b. 6
c. 1
d. 5
e. 2
f. 4
24. a, b, c, e, f, g, h
25. a. Have the gas company check for proper pressure at the main meter.
b. The water should level out at zero on each side of the scale.
c. The tube can be quickly slipped over an orifice spud.
d. Leave the manometer hooked up and turn on the range and all other gas appliances in the home.
26. a. (1) boned, tied
(2) pound
(3) foil
b. (1) fat
(2) aged
(3) standing
c. (1) thickest
(2) bone
(3) angle
(4) breast
27. a. fat
b. rare
c. (1) 1"
(2) refrigerator
(3) frozen, freezer
(4) broiler
(5) preheating
d. (1) browning
(2) butter, oil
(3) after
(4) rapidly, rare

Answers to Written Test

28. a. (1) middle
(2) oven wall
b. (1) recipe
(2) meat, poultry
c. (1) improper
(2) bottom
d. (1) aluminum
(2) glass pie plates
(3) cookies
(4) yeast
(5) frozen
29. a. 4
b. 1
c. 5
d. 3
e. 2
30. a, b, c, d, e

**Gas Ranges and Ovens
Unit 12**

Unit Evaluation Form

Name _____ Unit Rating _____

Assignment Sheet Ratings

Assignment Sheet 1—Determine Voltage and Resistance Readings
on a Self-Cleaning Gas Oven Set for Bake Operation Rating _____

Comments: _____

Assignment Sheet 2—Determine Voltage and Resistance Readings
on a Self-Cleaning Gas Oven Set for a Timed Bake Operation Rating _____

Comments: _____

Assignment Sheet 3—Determine Voltage and Resistance Readings
on a Self-Cleaning Gas Oven Set for a Cleaning Operation Rating _____

Comments: _____

Assignment Sheet 4—Determine Voltage and Resistance Readings
on a Self-Cleaning Gas Oven During Lock and Unlock Rating _____

Comments: _____

Job Sheet Ratings

Job Sheet 1—Install a Gas Range Level and Leak Free With All
Burners Properly Adjusted Rating _____

Comments: _____

Unit Evaluation Form

Job Sheet 2—Check Gas Oven Temperature for Proper Oven
Thermostat Settings

Rating _____

Comments: _____

Job Sheet 3—Recalibrate a Gas Oven Thermostat to Correct Settings

Rating _____

Comments: _____

Job Sheet 4—Remove, Disassemble, Clean, Lubricate, and
Reassemble a Standard Gas Burner Valve

Rating _____

Comments: _____

Written Test Scores

Pretest _____

Posttest _____

Other _____

Other _____

Teacher Signature _____ Date _____

Student Signature _____ Date _____

Permission to duplicate this form is granted.

300

**Electric Ranges and Ovens
Unit 13**

Unit Contents

Teacher Components

	Teacher Page
1. Suggested Activities	
a. Instructional Plan.....	1
b. Teaching Suggestions.....	2
c. Resources Used in Developing This Unit	2
d. Suggested Supplemental Resources	2
e. Instructions for Evaluating Student Performance	4
2. Written Test	5
3. Answers to Written Test.....	11
4. Unit Evaluation Form	13

Student Components

1. Objective Sheet	MAR-485
2. Information Sheet	MAR-487
3. Job Sheets	
JS 1—Check Surface Units From an Electric Range for Proper Resistance.....	MAR-499
JS 2—Check the Self-Cleaning Function on an Electric Oven	MAR-503
JS 3—Check Step-Type and Infinite Electric Range Switches for Continuity.....	MAR-507

Electric Ranges and Ovens

Unit 13

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction or individual learning activities. Study the specific objectives to determine the order in which you will present the objectives.
2. Review Teaching Suggestions section that follows. Plan for classroom activities.
3. Plan enrichment of exceptional students as well as accommodation of special needs students.
4. Add overheads or other graphic materials as desired to enhance instruction.
5. Develop teaching plan. Adjust for different learning styles.
6. Make copy of the Unit Evaluation Form for each student.

Delivery and Application

7. Provide students with unit of instruction.
8. Discuss unit and specific objectives.
9. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic skills when applicable.
10. Discuss and demonstrate activities in the job sheets. Review criteria for evaluating these activities.

Evaluation

11. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.
12. Make copies of written test. Add or modify test items as needed.
13. Give written test.
14. Compile job sheet ratings and written test scores on the Unit Evaluation Form. Include any additional assignment or job sheets added to the unit.
15. Reteach and retest as required.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface type in the Teaching Suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: a SCANS Report for America 2000*. These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

1. Review guidelines for roasting, broiling, and baking from "Gas Ranges and Ovens" in Unit 12. Point out to students how improper baking or cooking can provide clues to component problems with electric ranges and ovens. **Basic skills, science and listening; thinking skills, knowing how to learn.**
2. Review electrical safety rules for troubleshooting electric ranges and ovens. Note the dangers of an improper power connection, and other dangers posed by components that are badly worn but are still being used. **Basic skills, science; thinking skills, knowing how to learn.**
3. Have samples of step-type and infinite switches to show students when you discuss Objective 10. Demonstrate a griddle test for surface units, and show how a pan of water and a regular thermometer can be used if necessary. Outline the procedures in Job Sheet 3 and stress safety when working with live circuits. **Basic skills, science, math; thinking skills, knowing how to learn.**

Resources Used in Developing This Unit

1. Anderson, Edwin P. *Home Appliance Servicing*. Indianapolis, IN: Howard W. Sams and Company, Inc., 1984.
2. Bacon, Bill and Mark Sutton. *Major Appliance Repair*. Austin, TX: The University of Texas of Austin, 1983.
3. *Cooking Equipment Course*. Chicago, IL: Sears Training Center, n.d.

Suggested Supplemental Resources

1. Frigidaire service literature for electric ranges and ovens is available from:

Frigidaire Company
6000 Perimeter Drive
Dublin, OH 43017
614-764-8640

2. GE service literature for electric ranges and ovens is available from:

Dri-View Mfg. Co.
4706 Allmond Ave.
Louisville, KY 40209
or from GE Parts at 1-800-626-2002

308

Suggested Activities

3. Maytag and Norge service literature for electric ranges and ovens is available from:

Maytag Customer Service
Maytag Appliances
240 Edwards Street, S. E.
Cleveland, TN 37311
423-478-6788

4. Whirlpool and KitchenAid service literature for electric ranges and ovens is available from:

Whirlpool Corporation
Literature Department
1900 Whirlpool Drive
LaPorte, IN 46350-2585
1-800-851-4605

Suggested Activities

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

- 4 Skilled—Can perform job with no additional training.
- 3 Moderately skilled—Has performed job during training program; limited additional training may be required.
- 2 Limited skill—Has performed job during training program; additional training is required to develop skill.
- 1 Unskilled—is familiar with process, but is unable to perform job.

Option B

- Yes—Can perform job with no additional training.
- No—is unable to perform job satisfactorily

Electric Ranges and Ovens
Unit 13

Written test

Name _____ Date _____ Score _____

1. Match each term on the right with its correct definition.

- | | | |
|----------|--|----------------------|
| _____ a. | A chemical or other substances used to speed up or slow down a process such as the platinum/paladium screens that cause smoke to burn at lower temperatures in self-cleaning ovens | 1. Recalibrate |
| _____ b. | Electric range switches that provide a user with limited heat selections by cycling voltage on and off | 2. Step-type control |
| _____ c. | Electric range switches that provide a user heat selections in limited increments such as low, medium, and high by controlling voltage input only | 3. Catalyst |
| _____ d. | The procedure of adjusting a switch or control device so that it will perform to a specified standard | 4. Infinite controls |

2. Complete statements about electrical requirements for hooking up an electric range. Circle the word(s) or figure(s) that best completes each of the following statements.

- a. To operate properly, electric ranges require **(120V) (240V)** at 50 amps.
- b. Receptacles for electric ranges will accept only a three-prong or four-prong, **(straight-bladed) (single-ground)** plug.
- c. A dryer plug with an L-shaped blade should never be modified for use on an electric range because a dryer plug is designed for only **(30) (15)** amps and has smaller conductor wires.
- d. Anything less than the proper 3-prong or 4-prong range hookup is in **(violation of) (agreement with)** the National Electric Code and state and local codes.

Written Test

3. Select true statements about the basics of electric cooking. Place an "X" beside each true statement.

- ____ a. Instead of being rated in BTU's electric range heating elements are rated in amps.
- ____ b. Both surface heating elements and oven heating elements are made from an alloy of nickel and chromium called nichrome.
- ____ c. Heating elements have nichrome coils embedded in an insulated sheath, then covered with stainless steel tubing a design that produces efficiency.
- ____ d. Electric ranges produce no byproducts of combustion.
- ____ e. Electric ranges are preferred appliances in almost all areas.

4. Solve the following problems about servicing electric surface and oven heating element.

- a. What is the first thing that should be checked to troubleshoot a complaint of poor surface or oven heating?

Answer _____

- b. What simple test can determine whether or not an element needs to be replaced?

Answer _____

5. Differentiate between types of heat controls for surface heating elements. Place an "X" beside the definition of step-type controls.

- ____ a.
 - (1) Work by controlling voltage input only
 - (2) Controls permit use of both 240V and 120V in such a way that the two voltages may work individually or together for precise heat control
 - (3) Some controls have as few as three heat settings: high, medium, and low.
 - (4) Other controls may have five or even seven heat settings for temperature ranges that include high, medium-high, medium, low, medium-low, extra-low, and simmer.
- ____ b.
 - (1) Work by controlling voltage input timed in an on/off cycling pattern
 - (2) Most controls have 240V connected to the dual element, but some controls use 120V also.

Written Test

- (3) Controls may have unlimited heat settings or be limited to five or seven heat settings.
6. Complete statements about types of electric oven thermostats. Insert the word(s) that best completes each of the following statements.
- a. Bellows type:
- (1) A bellows expands or contracts as _____ oil in a capillary tube expands or contracts.
 - (2) As the bellows expands or contracts it _____ or _____ switch contacts which turn the oven heating element on or off.
- b. Bimetallic type:
- (1) A strip made of two _____ metals flattens or arches in response to temperature changes, and opens and closes switch contacts.
 - (2) As the switch contacts _____ and _____, the oven heating element is turned on or off.
- c. Diaphragm type:
- (1) A diaphragm expands or contracts in response to _____ from a capillary tube.
 - (2) The diaphragm activates or deactivates a click-action _____ that turns the oven heating element on or off.
7. Solve problems about recalibrating electric oven thermostats.
- a. What sort of check is required to determine if an oven thermostat needs to be recalibrated?
- Answer _____
- b. What should follow recalibration?
- Answer _____

Written Test

8. Solve problems about typical electric oven self-cleaning operation.

- a. Can the right rear surface element be used during a self-cleaning operation?

Answer _____

- b. What happens in a self-cleaning cycle when an oven reaches a temperature of about 550°F?

Answer _____

- c. At about 825°F, what happens to the HI LIMIT SWITCH?

Answer _____

- d. At what point may the oven door be opened again?

Answer _____

9. Match other components with their functions in a self-clean cycle.

_____ a. Must be pulled in place over the oven window before the oven door can be latched shut

_____ b. A mechanical latch that must be pushed to the far right in order for the self-cleaning function to be started

_____ c. A filter-type screen coated with a platinum/paladium combination and then oxidized to act as a catalyst which causes smoke to burn at a lower temperature

1. Smoke eliminator

2. Metal-mesh oven window screen

3. Lock latch

Written Test

10. Complete statements about troubleshooting electric ranges. Insert the word(s) that best completes each of the following statements.

a. When the oven will not heat or when the oven will not turn off, check for:

- (1) a blown _____
- (2) loose _____
- (3) selector _____ problems
- (4) timer _____
- (5) _____ thermostat
- (6) _____ bake element
- (7) control _____ problems

b. When a surface unit will not heat, is always on high, or has too much heat on a low setting, check for:

- (1) a blown _____
- (2) loose or _____ connection
- (3) an _____ in the element itself
- (4) bad surface unit _____

c. When a timer appears to be malfunctioning, check for:

- (1) loose connections or _____ connections
- (2) bad timer _____
- (3) bad _____

d. When an oven door does not close properly, check for:

- (1) worn pins or _____ brackets
- (2) problems with the oven door _____ or misalignment

Written Test

e. When a self-cleaning function does not operate, check for:

- (1) problems with _____ and broil circuitry
- (2) problems with selector switch or oven _____
- (3) blown _____
- (4) problems with the safety _____ system

Permission to duplicate this test is granted.

Electric Ranges and Ovens
Unit 13

Answers to Written Test

1.
 - a. 3
 - b. 4
 - c. 2
 - d. 1
2.
 - a. 240V
 - b. Straight-bladed
 - c. 30
 - d. Violation of
3.
 - b, c, d
4.
 - a. Check all connectors
 - b. A continuity test
5.
 - a
6.
 - a.
 - (1) Silicon
 - (2) Opens, closes
 - b.
 - (1) Dissimilar
 - (2) Opens, close
 - c.
 - (1) Pressure
 - (2) Switch
7.
 - a. An oven temperature check
 - b. An oven temperature check
8.
 - a. No
 - b. The door lock switch activates a locking screw into position so that the lock lever cannot be removed
 - c. It cycles on and off to maintain required heat until the clock timer runs through the programmed clean time
 - d. When the oven cools to between 325°F and 250°F and the door lock lever can be moved manually to the left.
9.
 - a. 2
 - b. 3
 - c. 1
10.
 - a.
 - (1) fuse
 - (2) wire or wires
 - (3) switch
 - (4) problems
 - (5) defective
 - (6) defective
 - (7) circuitry

Answers to Written Test

- b. (1) fuse
(2) incorrect
(3) open
(4) switch
- c. (1) wrong
(2) motor
(3) timer
- d. (1) hinge
(2) seal
- e. (1) bake
(2) thermostat
(3) fuse
(4) interlock

**Electric Ranges and Ovens
Unit 13**

Unit Evaluation Form

Name _____ Unit Rating _____

Job Sheet Ratings

Job Sheet 1—Check Surface Units From an Electric Range
For Proper Resistance

Rating _____

Comments: _____

Job Sheet 2—Check the Self-Cleaning Function on an Electric Oven

Rating _____

Comments: _____

Job Sheet 3—Check Step-Type and Infinite Electric Range Switches

Rating _____

Comments: _____

Written Test Scores

Pretest _____

Posttest _____

Other _____

Other _____

Teacher Signature _____ Date _____

Student Signature _____ Date _____

Permission to duplicate this form is granted.

314

**Microwave Ovens
Unit 14**

Unit Contents

Teacher Components

	Teacher Page
1. Suggested Activities	
a. Instructional Plan.....	1
b. Teaching Suggestions.....	2
c. Resources Used in Developing This Unit	2
d. Suggested Supplemental Resources	3
e. Instructions for Evaluating Student Performance	4
2. Answers to Assignment Sheets	5
3. Written Test	7
4. Answers to Written Test.....	21
5. Unit Evaluation Form	25

Student Components

1. Objective Sheet	MAR-511
2. Information Sheet	MAR-515
3. Student Supplements	
Student Supplement 1—Microwave Oven Components.....	MAR-529
Student Supplement 2—Circuit Diagnosis	MAR-531
Student Supplement 3—Circuit Diagnosis, Oven in COOK Condition.....	MAR-535
Student Supplement 4—Circuit Diagnosis, Oven in VARI-COOK Condition	MAR-541
4. Assignment Sheets	
AS 1—Diagnose Circuit Problems When an Oven is in a Cavity-Light ON Condition.....	MAR-545
AS 2—Diagnose Circuit Problems When an Oven is in the COOK Condition	MAR-547
AS 3—Diagnose Circuit Problems When an Oven is in the VARI-COOK Condition	MAR-549

Unit Contents

5. Job Sheets

JS 1—Test the Interlock System on a Microwave Oven for Safe Operation	MAR-551
JS 2—Check an RF Leakage Test Meter and Check a Microwave Oven For RF Leakage	MAR-555
JS 3—Clean and Deodorize a Microwave Oven	MAR-563
JS 4—Determine if Selected Utensils are Microwave Safe	MAR-565
JS 5—Discharge a Capacitor	MAR-567
JS 6—Check Stirrer Blade Rotation and Remove and Disassemble a Stirrer System	MAR-569
JS 7—Replace and Adjust a Microwave Oven Door Assembly	MAR-575
JS 8—Conduct Power Tests on a Microwave Oven to Check For Temperature Rise Under Full Power	MAR-579
JS 9—Test and Replace High Voltage Components When an Oven Produces Little or No Heat	MAR-581
JS 10—Remove a Blower Motor and Transformer and Remove and Reinstall a Magnetron	MAR-585
JS 11—Check the Interlock Switch Module on a Microwave Oven	MAR-591
JS 12—Test and Replace Magnetron and Cavity Thermal Protectors	MAR-593
JS 13—Test and Replace a Low Voltage Transformer and a Triac Module	MAR-601
JS 14—Test a Temperature Probe and Probe Jack	MAR-607
JS 15—Test and Replace an Oven Timer and an Oven Controller	MAR-611
JS 16—Remove, Test, and Replace a Control Board	MAR-615
JS 17—Test a Control Circuit Board	MAR-623
JS 18—Test a Cook Relay	MAR-627
JS 19—Test and Replace a Turntable Motor	MAR-631

316

**Microwave Ovens
Unit 14**

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction or individual learning activities. Study the specific objectives to determine the order in which you will present the objectives.
2. Review Teaching Suggestions section that follows. Plan for classroom activities.
3. Plan enrichment of exceptional students as well as accommodation of special needs students.
4. Add overheads or other graphic materials as desired to enhance instruction.
5. Develop teaching plan. Adjust for different learning styles.
6. Make copy of the Unit Evaluation Form for each student.

Delivery and Application

7. Provide students with unit of instruction.
8. Discuss unit and specific objectives.
9. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic skills when applicable.
10. Discuss and demonstrate activities in the job sheets. Review criteria for evaluating these activities.

Evaluation

11. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.
12. Make copies of written test. Add or modify test items as needed.
13. Give written test.
14. Compile job sheet ratings and written test scores on the Unit Evaluation Form. Include any additional assignment or job sheets added to the unit.
15. Reteach and retest as required.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface type in the Teaching Suggestions refer to the academic and workplace skills identifies in *What Work Requires of Schools: a SCANS Report for America 2000*. The SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

1. Because of low-cost microwave ovens at discount stores, microwave ovens are often discarded instead of repaired. Discuss this with students and explain that low-cost microwave ovens are often built without a stirrer assembly and that cooking food in such ovens does not always produce a quality product. Stress customer service and the benefits of having a good microwave repaired instead of replacing it with a discount model. **Basic skills, listening; Interpersonal skills, customer service.**
2. Talk about safety throughout this unit, especially safety when working with live circuits. Demonstrate how to avoid making your body part of a circuit by working with only one hand, or keeping a free hand in a pocket. Stress the value of alligator clips in microwave oven troubleshooting. **Basic skills, science; thinking skills, knowing how to learn; personal management skills, responsibility.**
3. Demonstrate how to safely discharge a capacitor and make sure each student in the class conducts this procedure under your supervision. Show how to use a screwdriver with an insulated handle to discharge a capacitor, but stress the proper use of a bleed resistor for the process. **Basic skills, science, math; thinking skills, knowing how to learn.**

Resources Used in Developing This Unit

1. *Commercial Systems Information Manual, Systems 70 Microwave Ovens*. Minneapolis, MN: Litton Systems, Inc., 1984.
2. *Litton Microwave Service Training Manual, Commercial Basics*. Minneapolis, MN: Litton Systems, Inc., 1984.
3. *Microwave Oven Service Manual (1300 and 1400 series)*. Minneapolis, MN: Litton Systems, Inc., 1984.
4. *Microwave Oven Service Manual (Generation II, All Models)*. Minneapolis, MN: Litton Systems, Inc., 1984.
5. *Procedures for Testing Microwave Ovens*. Rockville, MD: U.S. Department of Health, Education, and Welfare, 1977.

Suggested Activities

Suggested Supplemental Resources

1. Frigidaire service literature for microwave ovens is available from:

Frigidaire Company
6000 Perimeter Drive
Dublin, OH 43017
614-764-8640

2. GE service literature for microwave ovens is available from:

Dri-View Mfg. Co.
4706 Allmond Ave.
Louisville, KY 40209
or from GE parts at 1-800-626-2002

3. Maytag service literature for microwave ovens is available from:

Maytag Customer Service
Maytag Appliances
240 Edwards Street, S.E.
Cleveland, TN 37311
423-478-6788

4. Whirlpool and KitchenAid service literature for microwave ovens is available from:

Whirlpool Corporation
Literature Department
1900 Whirlpool Drive
LaPorte, IN 46350-2585
1-800-851-4605

5. Amana service literature for microwave ovens is available from:

Consumer Affairs Dept.
Amana Appliances
Amana, IA 52204
1-800-843-0304

Suggested Activities

Instructions for Evaluation Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process Evaluation--Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product Evaluation--Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review appropriate materials and submit another product for evaluation.

Option A

- 4 Skilled—Can perform job with no additional training.
- 3 Moderately skilled—Has performed job during training program; limited additional training may be required.
- 2 Limited skill—Has performed job during training program; additional training is required to develop skill.
- 1 Unskilled—is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

No—is unable to perform job satisfactorily

Microwave Ovens
Unit 14

Answers to Assignment Sheets

Assignment Sheet 1

Answer should include any four of the following:

- a. Blown fuse or tripped circuit breaker
- b. Blown 15-amp oven fuse
- c. Defective cavity thermal protector
- d. Defective lower door interlock switch
- e. Defective cavity light
- f. Defective cavity light socket
- g. Broken or loose wire connection

Assignment Sheet 2

- Problem 1:
- a. Defective timer switch
 - b. Broken or loose wire connection

Problem 2: Any two of the following:

- a. Defective primary (lower door) interlock switch
- b. Defective secondary (upper door) interlock switch
- c. Broken or loose wire connection

Problem 3: Any two of the following:

- a. Defective timer assembly
- b. Binding timer assembly
- c. Broken or loose wire connection

- Problem 4:
- a. Defective cook indicator light
 - b. Broken or loose wire connection

Problem 5: Any two of the following:

- a. Defective stirrer motor
- b. Stirrer blade binding
- c. Broken or loose wire connection

Answers to Assignment Sheets

Problem 6: Any two of the following:

- a. Defective blower motor
- b. Blower fan binding
- c. Broken or loose wire connection

Problem 7: Defective primary (lower door) interlock switch

Problem 8: Any five of the following:

- a. Vari-cook control not set to appropriate power level
- b. Low line voltage (should be at least 110V AC)
- c. Defective electro-mechanical controller
- d. Overheat condition causing thermal protector to open
- e. Defective magnetron
- f. Defective capacitor
- g. Defective power transformer

Problem 9: Any five of the following:

- a. Defective electro-mechanical controller
- b. Defective magnetron thermal protector
- c. Defective diode
- d. Defective capacitor
- e. Defective transformer
- f. Defective magnetron
- g. Broken or loose wire connection

Assignment Sheet 3

Answer: A defective electro-mechanical controller assembly

Microwave Ovens
Unit 14

Written Test

Name _____ Date _____ Score _____

1. Match each term on the right with its correct definition.

- | | | |
|----------|---|------------------|
| _____ a. | The generation of visible electrical sparks caused by microwaves striking and bouncing off objects with high metallic content | 1. Cycle |
| _____ b. | A government document published at required intervals to provide the general public with printed copies of new federal regulations or changes in existing regulations | 2. Rectifier |
| _____ c. | A way of stating whether a microwave oven is idle or going through a cycle that will defrost, warm, or cook food | 3. Arcing |
| _____ d. | The time it takes a microwave oven to perform a defrost, warm, or cook operation | 4. Diode |
| _____ e. | A device that permits electricity to flow in one direction only | 5. RF energy |
| _____ f. | A government agency which assigns and controls the use of electromagnetic frequencies | 6. Condition |
| _____ g. | The liquid or food placed into a microwave oven so microwaves will be absorbed instead of reflected back into the oven components | 7. FCC |
| _____ h. | A device that converts normal household current into pulsating DC current | 8. Load |
| _____ i. | A general reference to all forms of electromagnetic wavelengths including microwaves which have a frequency of 2450 MHz | 9. CFR |
| _____ j. | An abbreviated reference to "The Federal Performance Standard for Microwave Ovens" contained in 21 CFR, Subchapter J | 10. The Standard |

Written Test

2. Complete statements about microwaves and microwave ovens. Write in the word(s) that best completes each of the following statements.

- a. Microwaves are waves of energy that are 4.8 inches long and as thick as a _____.
- b. Microwaves are a part of the electromagnetic spectrum that includes several forms of _____ energy.
- c. Microwaves are considered non-ionizing and non-cumulative rays because they do not pack the energy of ionizing rays such as _____, and their effects on the human body do not build up.
- d. Microwave ovens generate microwaves in a _____ process that permits ovens to rapidly thaw, warm, or cook food.

3. Match microwave oven safety standards with their controlling agencies.

- | | | | |
|----------|---|----|---|
| _____ a. | Limits the frequencies available for microwave oven operations so that they can operate without interfering with communications devices | 1. | Department of Health and Human Services |
| _____ b. | Limits the acceptable amount of radiation that a microwave oven may emit and specifies door locks and monitoring system | 2. | Underwriters Laboratories |
| _____ c. | Requires that microwave ovens subscribe to safety standards for operation as an electrical device | 3. | Federal Communications Commission |

Written Test

4. Select true statements about the performance standard for microwave ovens. Place an "X" beside each true statement.
- ☐ a. The Performance Standard for Microwave Ovens applies to all microwave ovens manufactured after October 6, 1980.
 - ☐ b. Microwave emission shall not exceed 1 milliwatt per square centimeter at 5cm from the external surface of the oven prior to acquisition by the purchaser.
 - ☐ c. Microwave emission shall not exceed 5 milliwatts per square centimeter at anytime during the life of the oven.
 - ☐ d. Microwave ovens must have at least one safety interlock.
 - ☐ e. The interlock system must include a monitor which will cause the oven to become inoperative if either interlock fails.
 - ☐ f. RF leakage tests to determine microwave emission must be made with approved test instruments only.
 - ☐ g. Precaution labels concerning use and service must be attached to a microwave oven.
 - ☐ h. The label on a microwave oven must have only the name of the manufacturer.
5. Select true statements about FCC microwave standards. Place an "X" beside each true statement.
- ☐ a. Microwave ovens are assigned operating frequencies by the FCC so they will not interfere with other frequencies.
 - ☐ b. Microwave frequencies include 915 MHz and 2450 MHz, but almost all modern countertop microwave ovens use the 915 MHz frequency.
 - ☐ c. Other microwave frequencies do have specific FCC assignments, but these frequencies are reserved for TV stations.
 - ☐ d. The label on a microwave oven must list the operating frequency of the oven and indicate FCC approval.

Written Test

6. Match basic components with their functions in a microwave oven.

- | | | |
|----------|---|------------------------|
| _____ a. | This is usually a magnetron which generates microwaves and directs them from an antenna into a transmission device or an oven cavity | 1. Transmission device |
| _____ b. | This is usually a waveguide which acts as a chute through which microwaves are directed into the oven cavity | 2. Oven cavity |
| _____ c. | This is usually a fan-like device called a stirrer which spreads the microwave in a random pattern to assure even distribution of the microwaves into the oven cavity | 3. A microwave source |
| _____ d. | A resonant chamber into which food is placed for thawing, heating, or cooking | 4. Interlock system |
| _____ e. | Primary and secondary safety devices on a microwave oven door to assure that microwave transmission will stop immediately when the door is opened | 5. Distribution device |

7. Complete statements about magnetron structure and operation. Insert the word(s) that best completes each of the following statements.

- a. Most magnetrons are constructed as a series of cylinders:
- (1) The outer cylinder is a permanent _____.
 - (2) The middle cylinder is an _____ with vanes or ridges in it that create "resonant cavities".
 - (3) The inner cylinder is a _____ with a heating filament in the center.
- b. As high voltage is supplied to the magnetron from a _____, the filament heats the cathode.
- c. As the cathode is heated, it gives off electrons whose _____ charges are attracted to the anode which operates at a positive potential.
- d. The magnetic fields around the anode _____ the electrons so that they travel in a circular path to reach the anode instead of traveling in a straight line as electrons normally would.

Written Test

- e. As the electrons move in a rapid orbit from cathode to anode, they travel past the resonant cavities in the anode and cause the cavities to _____ at a high frequency.
 - f. The pulsating 2450 MHz frequency generated by the magnetron is picked up by the _____ and directed into a waveguide and on to a stirrer which distributes the microwaves into the oven cavity.
8. Complete statements about the significance of microwave reflection. Circle the word(s) that best completes each of the following statements.
- a. The walls inside a microwave **(always)** **(never)** get hot because metal **reflects** microwaves, and for that same reason, a microwave oven should never be operated without a load.
 - b. Metal utensils cannot be used in a microwave because they cause **(arcing)** **(melting)** that can damage components.
 - c. Aluminum foil **(can)** **(cannot)** be used in limited quantity to shield parts of food to assure even cooking.
9. Complete statements about the significance of microwave transmission. Circle the word(s) that best completes each of the following statements.
- a. Since microwaves easily **(penetrate)** **(heat)** glass, paper, and plastic, most utensils made from these materials are safe for use in a microwave oven.
 - b. Glass utensils are best for foods high in **(fat or sugar)** **(acid)** content because such foods can distort certain plastics.
 - c. Paper towels can be used **(beneath)** **(over)** foods to help keep the oven clean or placed **(over)** **(beneath)** bacon to avoid splatter.
10. Complete statements about the significance of microwave absorption. Circle the word(s) that best completes each of the following statements.
- a. The fact that foods **(absorb)** **(reflect)** microwaves is the key to microwave cooking.
 - b. The process of absorption is also used to defrost frozen foods or to keep foods warm by employing a timed sequence in which the magnetron is **(on for a while then off for awhile)** **(put on low power)**.
 - c. How fast foods absorb microwaves depends on the amount of food, temperature of the food when cooking starts, and even the **(shape)** **(weight)** of food.

Written Test

11. Arrange in order the steps in microwave cooking. Place the correct sequence number in the appropriate blank.

- ____ a. Food molecules oscillate back and forth four billion, nine hundred million times every second.
- ____ b. The ultra high-speed oscillation produces friction between the molecules which converts the microwave energy to instant heat.
- ____ c. Microwaves penetrate food up to a depth of 2 inches and accelerate the conduction of heat, but microwaves do not cook food from the inside out.
- ____ d. As microwaves enter food, they set up electrical fields that change polarity every half cycle.
- ____ e. Molecules in the food, especially water and fat molecules, start moving back and forth and changing directions every half cycle just as the microwaves do.

12. Arrange in order the steps in installing a microwave oven. Place the correct sequence number in the appropriate blank.

- ____ a. Push button to put the oven in a COOK cycle for 30 seconds.
- ____ b. Open oven door, remove water, and check water to make sure it has been heated.
- ____ c. Place the oven in location and check for:
 - (1) one inch of clearance at the top and back.
 - (2) two to three inches clearance on each side.
 - (3) sufficient clearance to assure air flow at the bottom of the oven.
- ____ d. Heated water indicates oven is ready for operation.
- ____ e. If oven has been stored in a cold location, let it warm to room temperature before operating.
- ____ f. Place a cup of water in the oven cavity and close the door.
- ____ g. Check the oven thoroughly to assure there is no damage.
- ____ h. Plug oven into a 120 volt, three-prong or four-prong grounded outlet only.
- ____ i. Check for at least a 15-amp circuit and make sure the microwave is the only appliance on that circuit.
- ____ j. Remove all material from the oven interior.

Written Test

13. Select true statements about general rules for preventive maintenance. Place an "X" beside each true statement.

- ☐ a. Clean the stirrer cover and the oven with a damp cloth after each use.
- ☐ b. Wipe out excess moisture after every use.
- ☐ c. Use steel wool to clean up stubborn soils.
- ☐ d. Use a damp cloth to clean a temperature probe after each use, and dry the probe after cleaning, but do not put the probe into dishwater or a dishwasher.
- ☐ e. Use a knife to scrape the stirrer cover clean.
- ☐ f. Remember that caked-on food buildup on oven or door surfaces affects oven performance.
- ☐ g. A clean oven looks better, smells better, and cooks better.
- ☐ h. Inspect air intakes and outlets weekly to make sure someone has not blocked them.

Written Test

14. Match major microwave oven components with their functions.

- | | | |
|----------|--|----------------------------|
| _____ a. | A transformer that converts 120V AC current into low voltage that is fed to the magnetron filaments, and into high voltage that is fed into the voltage-doubler circuit | 1. Waveguide |
| _____ b. | A diode/rectifier/capacitor combination that converts the high voltage AC feed from the transformer into approximately 3900V pulsating DC current that is fed into the magnetron | 2. Antenna |
| _____ c. | A cylinder-shaped cathode/anode in a magnetic field that converts applied low voltage AC and high voltage DC current into microwaves | 3. Power transformer |
| _____ d. | The part of the magnetron tube that directs generated microwaves into a waveguide | 4. Stirrer assembly |
| _____ e. | A duct-like channel through which the microwaves travel in controlled transmission to the stirrer assembly | 5. Voltage-doubler circuit |
| _____ f. | A device with fan-like blades that scatter the microwaves at random into the oven cavity to assure even heat distribution in the cavity | 6. Magnetron |

15. Select true statements about requirements for RF leakage test instruments. Place an "X" beside each true statement.

- _____ a. Leakage test instruments must always be set at a frequency of 918 MHz.
- _____ b. Leakage test instruments must have a response time that permits them to reach 90% of their response capacity in only three seconds.
- _____ c. Batteries in test instruments should be checked once a year.
- _____ d. Spacer cones and probes should be checked prior to each use to assure they are clean and undamaged.

Written Mail

16. Complete statements about spacer cones. Insert the word(s) or figure(s) that best completes each of the following statements.
- a. Spacer cones are fitted over detector probes to assure that the _____ of the probe is kept 5 cm, about 2", from external surfaces such as latches and control knobs.
 - b. The spacer cone is also used to assure that the detector is held at a _____ angle to the oven surface or area being tested.
 - c. When testing seams on an oven, do not force the spacer cone into the discontinuity between the _____, keep the spacer cone at a proper angle and retain the 5 cm or 2" distance.

Written Test

17. Match operating controls with their functions.

- | | | |
|---------|--|------------------------|
| _____a. | These switches are activated by the opening of closing of the oven door to assure that microwave generation does not start until the door is properly closed and stops the moment the door is opened | 1. Timer |
| _____b. | A device that instantly shuts off microwave transmission in the event any interlock switch fails | 2. Interlock monitor |
| _____c. | May be a rotary, digital, push-button, or touchpad device, and is designed to stop microwave generation at the end of a specific period | 3. Cook relay |
| _____d. | Permits selection of COOK, DEFROST or other conditions of a particular oven, and some oven doors cannot be opened until STOP has been pressed | 4. Triac |
| _____e. | Devices which stop oven operations in the event a blower obstruction causes a magnetron to overheat or the oven cavity to overheat | 5. Interlock switches |
| _____f. | Activated by depressing the COOK switch to generate a current path to the stirrer assembly, transformer, and cook light | 6. Controller |
| _____g. | Used on microwave ovens to start and stop microwave transmission for thawing food or keeping food warm during a variable heat cycle. | 7. Thermal protectors |
| _____h. | A switching relay used for controlling circuits in a microwave oven | 8. Start/stop controls |

Written Test

18. Complete statements about motors in microwave ovens. Insert the word(s) that best describe each of the following statements.
- a. Blower motor--A motor that drives a fan which directs air around the vanes of the magnetron to help keep it cool and also directs some air through the oven cavity to remove _____ and vapors from cooking food
 - b. Stirrer motor--A motor that drives a fan which deflects microwaves from the waveguide into the _____
 - c. Turntable motor--A motor that drives the _____ tray in some microwaves ovens
19. Select true statements about door seals and their importance in microwave oven construction. Place an "X" beside each true statement.
- ____ a. Door seals must be so designed that they prevent the escape of microwaves from the oven.
 - ____ b. Door seals must be so designed that they can limit RF leakage from the oven door to a maximum level of 5mw/cm^2 .
 - ____ c. A "capacitive seal" is a flexible metal plate with a thin insulated coating to break metal-to-metal contact and prevent arcing when the oven door is closed.
 - ____ d. A "choke seal" is so structured that the dimensions are related to the wavelengths of microwaves, and will actually reflect stray microwaves back into the oven cavity.
 - ____ e. "Absorbent seals" are made of plastic or synthetic rubber and may have a ferritic content to help them absorb harmonic energy that might get by the other seals.
 - ____ f. Door seals are critical to safe microwave oven operation and should be inspected every year.

Written Test

20. Complete statements about technical materials required for microwave oven service. Insert the word(s) that best completes each of the following statements.
- a. The nameplate on the oven should always be checked for the proper model number and _____ number.
 - b. The _____ manual for the specific oven being worked on must be available to assure proper references for circuitry and parts.
 - c. Service bulletins, technical updates, or literature that lists _____ changes that affect component or parts modifications for the oven must be available.
 - d. Replacement parts should be ordered by _____ from the parts catalog for the specific oven being serviced.
 - e. Circuit diagnosis and troubleshooting should not begin without a proper _____ schematic for the specific oven being serviced.
21. Arrange in order the steps in troubleshooting a microwave oven. Place the correct sequence number in the appropriate blank.
- _____ a. Make a RF leakage test after repairs are complete.
 - _____ b. Run the oven through a complete operating cycle to insure everything is in order.
 - _____ c. Make sure your technical materials reflect engineering changes and are otherwise up to date.
 - _____ d. Start with a proper wiring schematic and a circuit diagnosis.
 - _____ e. Complete pre-service inspection and make sure you have the model and serial number for reference.
 - _____ f. Check troubleshooting procedures in service manual.
 - _____ g. Perform components tests in order.
 - _____ h. Use a parts catalog that specifically lists parts and components for the oven being repaired.

Written Test

22. Complete statements about pre-service inspection requirements for microwave ovens. Insert the word(s) that best completes each of the following statements.
- a. Check _____ operations and proper door closing.
 - b. Examine the seals and _____ surfaces for signs of arcing, wear, or damage that could endanger the integrity of the _____.
 - c. Check the door _____ to make sure they are not loose or damaged.
 - d. Examine the oven wrap and all exterior surfaces for evidence or misuse or abusive use such as _____.
 - e. Check the magnetron and _____ for proper alignment.
 - f. Check the _____ assembly.
 - g. If there is evidence of _____ or doubts about the microwave generating components, the oven should not be serviced.
23. Complete statements about safety requirements for microwave oven service. Insert the word(s) that best completes each of the following statements.
- a. Always _____ the oven before starting any tests or service.
 - b. Unplug the _____ to the oven before removing access panels or oven wraps.
 - c. DISCHARGE THE CAPACITOR by shorting across the capacitor terminals with a screwdriver that has an _____ handle.
 - d. When a test routine calls for operating the oven for a _____ test, make all test connections BEFORE YOU PLUG THE UNIT INTO THE POWER RECEPTACLE.
 - e. Use _____ when making "live" tests so you will not have to hold VOM leads near areas of dangerous high voltages.
 - f. Operate the unit only from a three-prong or four-prong _____ outlet on a 15-amp circuit that services the microwave only.
 - g. When using an extension cord for testing, use a three-wire grounded cord of at least 16-gauge copper, but do not use a _____ extension cord.
 - h. _____ take high voltage readings around the transformer or the magnetron.
 - i. Rings, bracelets, watches and watch band, metallic neck chains, and metal jewelry of any kind could accidentally touch a nearby component and cause severe injury for a technician servicing microwave components; _____ before accessing and testing interior operating components of a microwave.

Written Test

24. Complete statements about post-service safety requirements for microwave ovens. Insert the word(s) that best completes each of the following statements.
- a. Attach a note to the oven to indicate what the customer can do to avoid further problems if the problem resulted from any form of misuse or lack of proper _____.
 - b. Conduct an _____ to assure that oven microwave emissions are at or below the 5mw/cm^2 maximum level set by the Department of Health and Human Services.
 - c. Fill out a leakage test tag listing the type of leakage test instrument used, the serial and model numbers of the oven, the _____ the test was made, and the signature of the technician that made the test.

Permission to duplicate this test is granted.

**Microwave Ovens
Unit 14**

Answers to Written Test

1. a. 3 f. 7
 b. 9 g. 8
 c. 6 h. 2
 d. 1 i. 5
 e. 4 j. 10

2. a. pencil
 b. RF
 c. X-rays
 d. controlled

3. a. 3
 b. 1
 c. 2

4. b, c, e, f, g

5. a, d

6. a. 3
 b. 1
 c. 5
 d. 2
 e. 4

7. a. (1) magnet
 (2) anode
 (3) cathode
 b. transformer
 c. negative
 d. repels
 e. vibrate
 f. antenna

8. a. never
 b. arcing
 c. can

9. a. penetrate
 b. fat or sugar
 c. beneath, over

10. a. absorb
 b. on for awhile, then off for a awhile
 c. shape

337

Answers to Written Test

11. a. 3
b. 4
c. 5
d. 1
e. 2
12. a. 8
b. 9
c. 3
d. 10
e. 6
f. 7
g. 1
h. 4
i. 5
j. 2
13. a, b, d, f, g, h
14. a. 3
b. 5
c. 6
d. 2
e. 1
f. 4
15. b, d
16. a. center
b. 90
c. door, door
17. a. 5
b. 2
c. 1
d. 8
e. 7
f. 3
g. 6
h. 4
18. a. steam
b. oven cavity
c. revolving
19. a, b, c, d, e

333

Answers to Written Test

20. a. serial
b. service
c. engineering
d. number
e. writing
21. a. 7
b. 8
c. 3
d. 4
e. 1
f. 2
g. 5
h. 6
22. a. interlock
b. door, door
c. hinges
d. dropping
e. waveguide
f. stirrer
g. abuse
23. a. inspect
b. power cord
c. insulated
d. live
e. alligator clips
f. grounded
g. two-wire
h. NEVER
i. remove all jewelry
24. a. maintenance
b. RF leakage test
c. date

**Microwave Ovens
Unit 14**

Unit Evaluation Form

Name _____ Unit Rating _____

Assignment Sheet Ratings

Assignment Sheet 1--Diagnose Circuit Problems When an Oven is in
a Cavity-Light ON Condition

Rating _____

Comments: _____

Assignment Sheet 2--Diagnose Circuit Problems When an Oven is in
the COOK Condition

Rating _____

Comments: _____

Assignment Sheet 3--Diagnose Circuit Problems When Oven is in
a VARI-COOK Condition

Rating _____

Comments: _____

Job Sheet Ratings

Job Sheet 1--Test the Interlock System on a Microwave Oven
For Safe Operation

Rating _____

Comments: _____

Job Sheet 2--Check an RF Leakage Test Meter and Check a
Microwave Oven For RF Leakage

Rating _____

Comments: _____

Job Sheet 3--Clean and Deodorize a Microwave Oven

Rating _____

Comments: _____

Unit Evaluation Form

Job sheet 4--Determine if Selected Utensils are Microwave Safe

Rating _____

Comments: _____

Job Sheet 5--Discharge a Capacitor

Rating _____

Comments: _____

Job Sheet 6--Check Stirrer Blade Rotation and Remove and Disassemble a Stirrer System

Rating _____

Comments: _____

Job Sheet 7--Replace and Adjust a Microwave Oven Door Assembly

Rating _____

Comments: _____

Job Sheet 8--Conduct Power Tests on a Microwave Oven to Check for Temperature Rise Under Full Power

Rating _____

Comments: _____

Job Sheet 9--Test and Replace High Voltage Components When an Oven Produces Little or No Heat

Rating _____

Comments: _____

Job Sheet 10--Remove a Blower Motor and Transformer and Remove and Reinstall a Magnetron

Rating _____

Comments: _____

Unit Evaluation Form

Job Sheet 11--Check the Interlock Switch Module on a Microwave Oven

Rating _____

Comments: _____

Job Sheet 12--Test and Replace Magnetron and Cavity Thermal Protectors

Rating _____

Comments: _____

Job Sheet 13--Test and Replace a Low Voltage Transformer and a Triac Module

Rating _____

Comments: _____

Job Sheet 14--Test a Temperature Probe and Probe Jack

Rating _____

Comments: _____

Job Sheet 15--Test and Replace on Oven Timer and on Oven Controller

Rating _____

Comments: _____

Job Sheet 16--remove, test, and Replace a Control Board

Rating _____

Comments: _____

Job Sheet 17--Test a Control Circuit Board

Rating _____

Comments: _____

Unit Evaluation Form

Job Sheet 18--Test a Cook Relay

Rating _____

Comments: _____

Job Sheet 19--Test and Replace a Turntable Motor

Rating _____

Comments: _____

Written Test Scores

Pretest _____

Posttest _____

Other _____

Other _____

Teacher Signature _____ Date _____

Student Signature _____ Date _____

Permission to duplicate this form is granted.

343

Major Appliance Repair

Second Edition

Fundamentals of Electricity

Automatic Washers

Automatic Dryers

Automatic Dishwashers

Garbage Disposers

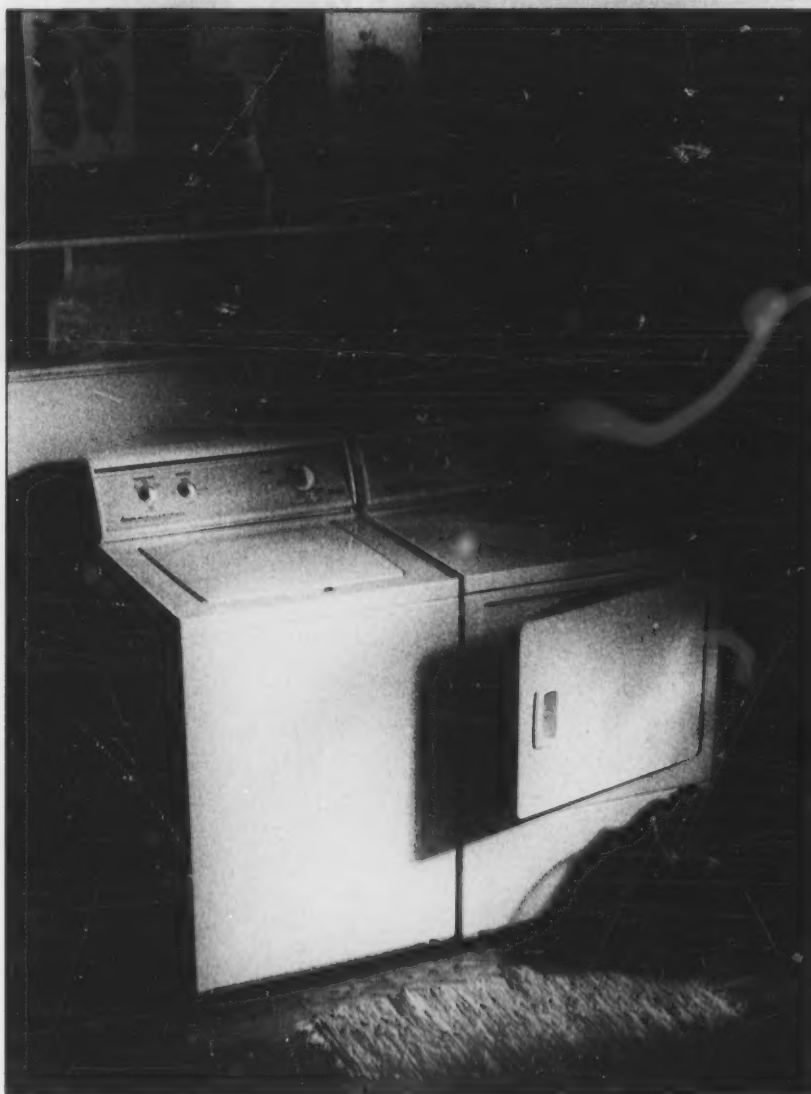
Trash Compactors

Gas Ranges and Ovens

Electric Ranges

Microwave Ovens

Customer Service



MAVCC

Multistate Academic and
Vocational Curriculum
Consortium

Student Edition

BEST COPY AVAILABLE

Major Appliance Repair

Second Edition

Student Edition

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Major Appliance Repair, Second Edition

Student Edition

Table of Contents

Unit 1:	Major Appliance Repair Orientation-----	1
Unit 2:	Safety and First Aid-----	15
Unit 3:	Fundamentals of Electricity-----	49
Unit 4:	AC Induction Motors-----	97
Unit 5:	Diagrams and Schematics-----	127
Unit 6:	Tools, Materials, and Test Equipment-----	155
Unit 7:	Automatic Washers-----	207
Unit 8:	Automatic Dryers-----	271
Unit 9:	Automatic Dishwashers-----	319
Unit 10:	Garbage Disposers-----	365
Unit 11:	Trash Compactors-----	385
Unit 12:	Gas Ranges and Ovens-----	419
Unit 13:	Electric Ranges and Ovens-----	485
Unit 14:	Microwave Ovens-----	511



Major Appliance Repair Orientation

Unit 1

Objective Sheet

Unit Objective

After completion of this unit, the student should be able to discuss training requirements and job opportunities for appliance repair technicians. The student should also be able to discuss the importance of good customer relations and critical elements in warranties. These competencies will be evidenced by scoring 85 percent on the written test.

Specific Objectives

After completion of this unit, the student will be able to:

1. Match terms related to major appliance repair orientation with their correct definitions.
2. Complete statements about the job outlook for appliance repair technicians.
3. Select true statements about advancement opportunities for appliance repair technicians.
4. Complete a list of places where appliance repair technicians work.
5. Select true statements about working conditions.
6. Complete statements about training requirements for appliance repair work.
7. Complete a list of physical requirements for successful appliance repair technicians.
8. Select true statements about personal habits that promote success on the job.
9. Complete statements about repair technicians and customer relations.
10. Complete statements about warranties and their importance.
11. Complete statements about cautions with warranties.
12. Solve problems about guidelines for service calls.

**Major Appliance Repair Orientation
Unit 1**

Information Sheet

1. Terms and definitions

- a. **Small appliances** – Labor saving devices such as can openers or toasters that are generally portable and relatively inexpensive
- b. **Major appliances** – Labor saving devices such as automatic washers and dryers that are generally stationary and relatively expensive

Note: This unit and the ones that follow are dedicated to major appliance repair.

- c. **Electromechanical** – A mechanical part such as a solenoid that is started or stopped by an electrical control device
- d. **Habit** – An act repeated so often that it becomes an automatic and unconscious personal trait

2. Job outlook for appliance repair technicians

- a. Well-trained appliance repair technicians should have good employment prospects through the year 2005, especially if their background in electronics is strong.
- b. Current technicians who advance to other jobs or retire will have to be replaced.
- c. The number of appliances in homes will continue to grow rapidly, but higher quality in general and the use of more reliable electronic parts in particular will lower the frequency with which they need to be serviced.
- d. Most people consider major appliances essential, and available work should continue even during periods of economic recession.
- e. Pay varies with geographical location, but experienced technicians in 1995-96 earned from \$15 to \$20 per hour or more, and wages should increase with each passing year.

3. Advancement opportunities for appliance repair technicians

- a. After two to three years experience and a good work record, repair technicians may be promoted to:
 - (1) supervisor.
 - (2) assistant service manager.
 - (3) service manager.

Information Sheet

- b. Highly skilled technicians with good people skills may advance to regional service manager or regional parts manager for a major manufacturer.
- c. A technician with a wide range of skills, experience, and sufficient financial support may open his/her own appliance store or repair shop.

4. Where appliance repair technicians work

- a. Most appliance repair technicians work in independent appliance stores and repair shops.
- b. Many more appliance repair technicians work for manufacturers' service centers, department stores, wholesalers, or utility companies.
- c. Some appliance repair technicians run their own businesses full or part time, and contract their services to service centers or appliance dealers.
- d. Appliance repair technicians work in communities of all sizes, but most of them work in highly populated metropolitan areas.

5. Working conditions

- a. Appliance repair shops are generally quiet, well lighted and ventilated, and comfortable places in which to work.
- b. Most technicians work with little or no direct supervisor, and most technicians enjoy this aspect of the occupation.
- c. The work is generally safe as long as safety procedures are observed around electrical elements of equipment and as long as lifting and moving of heavy appliances is accomplished properly.
- d. Technicians who repair appliances in customers' homes may sometimes have to drive a portion of the day and be responsible for the care of a company vehicle.
- e. Technicians who repair appliances in customers' homes also have to explain to the customer what repair work was done, the cost of parts and labor, and then collect the bill.

6. Training requirements for appliance repair work

- a. Although some repair technicians are trained on the job, formal training in appliance repair is the more common route into the industry.

Note: Formal training is available at some high schools, in many vocational-technical schools, in many community colleges, and in a variety of training programs from appliance manufacturers.

Information Sheet

- b. Training should stress both the mechanical and electrical aspects of the repair industry and the electromechanical.
- c. Modern appliances use more and more electronic parts, and technicians with good electronics skills have the best job prospects.



- d. Entry-level technicians frequently start out repairing one type of appliance until they master it and then learn other appliances one at a time.
- e. Large department stores and service centers have training programs of their own to help technicians master advanced areas of repair.
- f. Technicians who make service calls in customer homes generally go through a period of on-the-job training with a more experienced technician.
- g. Changes in appliance design demand that a technician keep up to date, and this usually means attending manufacturers' seminars where new models and service procedures are demonstrated.
- h. Service manuals provide a wealth of information, and a good repair technician should read all manuals available and maintain a personal library of service manuals.

7. Physical requirements for successful appliance repair technicians

- a. The occupation requires some heavy lifting which requires a person to be in generally good physical condition.
- b. The ability to identify wires of several different colors is essential for some electrical elements of the occupation, and good eyesight is required.
- c. Areas of the occupation require articulate skills in soldering and tinning, and the technician needs to have a steady hand.

Information Sheet

- d. Much of the work is repetitive and requires an ability to tolerate doing the same thing over and over.
- e. Technicians selected to service appliances in customers' home must have the verbal skills required to talk with customers.

8. Personal habits that promote success on the job

- a. Take a bath or shower daily and generally keep yourself neat and clean.

Note: Body odors irritate customers, and are not especially popular with fellow workers.

- b. Get to work on time, and if you know you're going to be late or if you're too ill to go to work, try to call in far enough in advance so arrangements can be made for others to cover your job.
- c. Respect all company property and use tools and equipment only for their intended purposes.
- d. Think of yourself as an advertisement for the company anytime you're on a service call or using a company vehicle in public, and conduct yourself properly.
- e. Avoid drugs or alcohol because their use can impair your ability to work safely or to work at all.
- f. Be honest in all your relations with supervisors, fellow-workers, and customers.
- g. Put in a day's work for your day's pay.

9. Repair technicians and customer relations

- a. Appliance repair technicians mostly work for dealers who sell and service appliances and whose business depends on good customer relations.
- b. Repair technicians need basic business skills in reading and interpreting work/service orders so they can approach customers with confidence.
- c. Repair technicians need basic math skills to total bills properly and avoid errors that could lose the company money or irritate a customer.
- d. Repair technicians must be diplomatic on service calls that take them into a customer's home.
- e. Repair technicians should assume they are part of the company image at all times and conduct themselves accordingly.

Note: Word of mouth is the most powerful form of advertising, and if you say bad things about the company you work for, it's bad advertising; if you don't like the place, quit and go to work someplace else.

10. Warranties and their importance

a. Warranty:

- (1) usually runs for one full year.
- (2) covers all defective workmanship and materials.
- (3) pays for both parts and labor.

b. Limited warranty:

- (1) usually runs from the second through the fifth year.

Note: Time periods vary with appliance and manufacturer, and some trash compactors and garbage disposers have no warranty past the first year.

- (2) usually covers only specific components such as the transmission on an automatic washer.
- (3) pays for parts, but customer pays for labor which includes travel costs.

c. Warranties should not be confused with dealer service contracts that provide special services beyond what the manufacturer warranties.

Note: Some dealer service contracts run up to ten years or more and may be limited or unlimited, but knowing if an appliance is under a warranty or a service contract is an important piece of information.

11. Cautions about warranties (Student Supplement 1)

a. Warranties are void if an appliance has been:

- (1) improperly installed or modified.
- (2) subjected to improper voltage supply.
- (3) subjected to unreasonable use.

Example: If an automatic washer designed for household use is used in a commercial laundry, that is unreasonable use.

b. Service or repair work performed by an unauthorized technician voids most warranties.

c. Payment for warranty work is made by manufacturers to authorized dealers and requires careful attention to paperwork. (Student Supplement 2)

Information Sheet

12. Guidelines for service calls**a. Prepare for the service call.**

- (1) Read the work order in advance.
- (2) Know the brand name, serial number, and model number of the appliance.
- (3) Examine the customer's description of the problem, and call the customer to clarify anything not clear.
- (4) Anticipate any special tools you may need and take them with you because trips back to the shop are expensive.
- (5) Take a service manual and parts catalog along just in case.
- (6) Check with the person who took the call if the order is incomplete or confusing.

b. Begin the service call tactfully.

- (1) Show up on time in clean work clothes or company uniform.
- (2) Park your car or service vehicle so it doesn't block a driveway, a sidewalk, or a mailbox.
- (3) Introduce yourself and explain who you represent and why you are there.

Note: Most people are very tentative about opening their door to strangers, and an intelligent self-introduction can help put the customer at ease.

- (4) Address the customer by his/her proper name, and ask how the name should be pronounced in case you're not sure.

Note: Do not hesitate to ask the customer how the name should be properly pronounced; if you're going to be in the home for awhile, the customer will not appreciate being addressed improperly.

- (5) Invite the customer to talk about the trouble in his/her own words because service order notes are sometimes very brief.

Note: Many service calls are taken over the telephone and many customers are not articulate in describing funny noises, unpleasant smells, or the many things that just can't be said without hand gestures.

Information Sheet

c. Keep the service call businesslike.

- (1) Refrain from accepting invitations to coffee or refreshments.
- (2) Request the customer to keep children and pets away from the work area for safety reasons.
- (3) Make no hasty statements about the problem or the cost of repairs.

Note: Part of the repair work is to also repair the customer's confidence in the product, the manufacturer, and the dealer for whom the service person works, and prompt, courteous repair is the best way to restore that confidence.

- (4) Always offer tips the customer can use to improve appliance service.
- (5) In cases where an appliance has simply had it, be smart enough to interest the customer in a replacement.

Note: The prospects that a worn out appliance still has a trade-in value may be the incentive a customer needs to buy a new appliance.

- (6) Leave the area clean.

**Major Appliance Repair Orientation
Unit 1**

Student Supplement 1 – Warranty

Frigidaire Dishwasher Warranty

FULL ONE-YEAR WARRANTY (Excluding Alaska)

Frigidaire Company warrants that Frigidaire will repair, without charge, any defect or malfunction occurring in this Dishwasher during the first year after original date of delivery to the consumer.

THIS WARRANTY DOES NOT APPLY:

1. To conditions resulting from (A) improper installation, or (B) incorrect electric current.
2. To conditions resulting from consumer damage, such as: (A) improper maintenance, or (B) misuse, abuse, accident, alteration.
3. If the original serial number cannot be readily determined.
4. To service calls not involving malfunction or defects in materials or workmanship, and naturally the consumer shall pay for such calls.
5. To Dishwashers installed outside the continental United States and Hawaii.
6. If used in any commercial application.
7. To Dishwashers installed in the State of Alaska.

LIMITED WARRANTY

Applicable to the State of Alaska

In the State of Alaska, all of the provisions of the full warranty and the exclusions thereunder listed on this form are unchanged, except that Frigidaire does not pay for the cost of the technician's travel to your home nor for the cost of transporting the product to his shop. You are responsible for these charges.

Courtesy Frigidaire

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

This is the only written warranty applicable to Frigidaire Dishwashers and Frigidaire neither assumes nor authorizes anyone to assume for it any other obligation or liability in connection with such Dishwashers. **FRIGIDAIRE SHALL NOT BE LIABLE FOR CONSEQUENTIAL DAMAGES, SUCH AS PROPERTY DAMAGE AND INCIDENTAL EXPENSES RESULTING FROM BREACH OF THIS WRITTEN WARRANTY OR ANY IMPLIED WARRANTY.**

Some states do not allow the exclusion or limitation of incidental or consequential damages, so this limitation or exclusion may not apply to you.

FOR SERVICE UNDER THIS WARRANTY contact any authorized Frigidaire servicing dealer, or if there is a question as to where to obtain warranty service, write our Customer Relations Department at this address.

FRIGIDAIRE COMPANY
P.O. Box WC4900
3555 S. Kettering Blvd.
Dayton, Ohio 45449

MAR-13

Major Appliance Repair Orientation Unit 1

Student Supplement 2 - Warranty Service Invoice

PRESS HARD - YOU ARE MAKING 5 COPIES

13L2490A

FORM 305.3 (REV. 2-79)

MAGIC CHEF WARRANTY SERVICE INVOICE

NO. A043374-S

CUSTOMER PHONE NUMBER: _____

CUSTOMER CALL DATE: _____

SERVICE AGENCY NAME ADDRESS & PHONE		CUSTOMER OR TENANTS NAME ADDRESS ZIP CODE		DEALER NAME ADDRESS ZIP CODE PHONE	
SIGNATURE		SIGNATURE			
NOTE TO TECHNICIAN : REFER TO REVERSE SIDE OF FORM FOR SERVICE CODE AND INDICATE HERE →					
APPLIANCE DATA →		POWER SOURCE LP NAT ELEC.		APPLIANCE PURCHASE DATE MO. DAY YEAR	
				MODEL #	
				SERIAL #	
SERVICE DATA →		DATE SERVICE CALL ARR. DEP. TOTAL MINUTES		2ND SERVICE CALL DATE ARR. DEP. TOTAL MINUTES	
TYPE APPLIANCE (CHECK ONE)		☐ DISHWASHER ☐ REFRIGERATOR ☐ SINK DISPOSAL ☐ VENT HOOD ☐ OTHER ☐ MICROWAVE OVEN ☐ R.F. LEAKAGE LEVEL		VENDOR CODE MAGIC CHEF USE ONLY ACCOUNT DISTRIBUTION	
☐ GAS RANGE ☐ ELECTRIC RANGE ☐ COUNTER TOP ☐ BUILT-IN OVEN ☐ EYE LEVEL CHATEAU ☐ COMPACTOR ☐ LAUNDRY ☐ FREEZER				5 9 9 7 5 4 1 1 PART CODE QUANTITY GROSS AMT DISCOUNT APPVD BY DATE 00-00-00	
PARTS INSTALLED		MAGIC CHEF APPROVAL			
PART #	QTY	DESCRIPTION	DM	DATE	RM DATE
A.					
B.					
C.					
D.					
E.					
F.					
G.					
CUSTOMER INITIAL DESCRIPTION OF SERVICE PROBLEM:					
DESCRIPTION OF SERVICE WORK PERFORMED:					
DATE WORK COMPLETED					

THIS FORM MUST BE COMPLETE AND INFORMATION MUST BE LISTED ON MONTHLY STATEMENT FORM 306-2 BEFORE PAYMENT BY MAGIC CHEF
 COMPLETED INVOICES WITH COPIES OF 306-2 SHOULD BE SENT TO WARRANTY SERVICE CO-ORDINATOR, MAGIC CHEF, INC., CLEVELAND, TENN. 37311

ORIGINAL (FACTORY COPY)

Courtesy Magic Chef Inc.

BEST COPY AVAILABLE

357

Safety and First Aid

Unit 2

Objective Sheet



Unit Objective

After completing this unit, the student should be able to discuss guidelines for electrical safety and list special safety requirements for appliance repair technicians. The student should also be able to select proper first aid procedures for given accidents, read and interpret a material safety data sheet, and sign a student safety pledge. The student should demonstrate these competencies by completing the activities in the assignment sheets and by scoring 100 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to safety and first aid with their correct definitions.
2. Complete a list of benefits of safe working practices.
3. Select true statements about the major causes of accidents.
4. State the motto for good housekeeping.
5. Complete statements about basic rules for safe use of tools and equipment.
6. Arrange in order the steps in lifting safely.
7. Select true statements about special lifting rules for appliance repair.
8. Match MSDS information with its details.
9. Complete statements about problems and health effects of hazardous chemicals.
10. Solve problems about the diamond classification system for hazardous chemicals.
11. Complete statements about fire safety rules.
12. Match classes of fires with their causes.
13. Match types of fire extinguishers with their recommended uses.
14. Match types of fire extinguishers with their recommended operations.

Objective Sheet

15. Complete statements about special safety requirements for appliance repair.
16. Complete statements about special rules for eye protection.
17. Select true statements about ways to recognize shock.
18. Arrange in order the steps in treating shock.
19. Complete statements about first aid for victims of electrical shock
20. Select true statements about first aid guidelines for common workplace injuries.
21. Select true statements about first aid for workplace burns.
22. Arrange in order the steps in controlling bleeding.
23. Complete statements about pressure points for checking bleeding.
24. Select true statements about first aid for eye injuries.
25. Complete statements about general guidelines for first aid emergencies.
26. Select proper first aid procedures. (Assignment Sheet 1)
27. Solve problems about hazardous materials. (Assignment Sheet 2)
28. Complete a student safety pledge. (Assignment Sheet 3)

Safety and First Aid Unit 2

Information Sheet

1. Terms and definitions

- a. **Accident**—Any suddenly occurring, unintentional event which causes personal injury or property damage
- b. **Bloodborne pathogen**—A disease-causing microorganism found in infected blood and blood products
- c. **Combustible**—Materials or liquids that catch fire easily
- d. **First aid**—Immediate, temporary care given the victim of an accident or sudden illness until the service of a physician can be obtained
- e. **Hygiene**—The science of good health and its maintenance, including sanitary practices and cleanliness
- f. **MSDS (Material Safety Data Sheet)**—A form that explains a hazardous material so that employees can use it safely and respond properly to emergency situations
- g. **Pressure points**—Points on the body where arteries pass close to the surface of the skin and in front of bone structure so that pressure forcing the artery against the bone can check the flow of blood to a specific part of the body
- h. **Safety**—State or condition of being safe, free from danger, risk, or injury
- i. **Tetanus**—An acute, infectious disease that usually enters the body through cuts or wounds; characterized by spasmodic contractions or rigidity of some voluntary muscles, and frequently referred to as lockjaw
- j. **Tourniquet**—A bandage or strap twisted around a limb to compress the flow of blood through arteries and check severe bleeding

2. Benefits of safe working practices

- a. Eliminates the pain or discomfort of personal injury
- b. Eliminates the loss of equipment or the expense of repair
- c. Eliminates lost time and lost wages
- d. Contributes to the psychological well being of all employees
- e. Contributes to productivity and job security
- f. Fulfills the moral obligation a worker has to employer and fellow employees

Information Sheet

3. The major causes of accidents

- a. Unsafe condition—May be caused by improper design, improper installation, or improper maintenance of a tool, machine, or any piece of equipment

Example: Unguarded machinery, mushroomed heads on striking tools, poor housekeeping, and poor lighting are all unsafe conditions

- b. Unsafe act—The violation of a commonly accepted safe practice

Example: Removing machinery guards, throwing material instead of carrying it, improper lifting, and horseplay are all unsafe acts

- c. Combination causes—An unsafe condition combined with an unsafe act causes the majority of accidents

Example: Firmly grasping a wrench being pushed toward an open metal edge can severely injure knuckles and fingers if the wrench slips or the nut loosens sooner than expected

4. Rules for good housekeeping

- a. Keep tools and materials out of passageways.
- b. Stack materials neatly away from passageways, walkways, electrical outlets, and work areas.
- c. Place scraps that can't be used in a trash can; return materials that can still be used to stock.
- d. Immediately wipe up any oil or water that you or anyone else may have spilled on the floor.
- e. Store all rags in a fire-proof metal container with a tight lid.
- f. Dispose of oily rags that will not be used again, and be sure to place them in a proper receptacle.
- g. Practice good housekeeping at all times because it is one of the most important parts of accident prevention.
- h. Inspect electrical cords and plugs before using them, and do not carelessly pull or drag an electrical cord when using it.
- i. Return tools and unused materials to proper storage when you're through with a job, and make sure the tools are clean and dry.
- j. Remember the motto for good housekeeping: a place for everything and everything in its place.

Information Sheet

5. Basic rules for safe use of tools and equipment

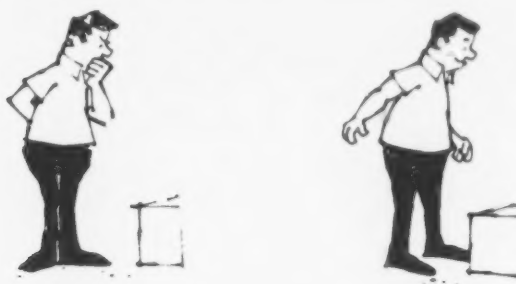
- a. When using a screwdriver, support the work on a bench or against a solid surface.
- b. When using a wrench, pull it toward the body to prevent smashing your hand if the wrench should slip.
- c. Do not strike a mushroomed punch or chisel, pieces of it may strike you in the eye or the hammer may slip and injure your hand.
- d. Wear safety goggles when using striking tools.
- e. Be especially careful of burrs and fish hooks which are left on the edge of sheet metal; they can cause severe cuts.
- f. Never use a file without a handle; the tang could easily pierce your hand and cause a serious injury.
- g. When working with a drill press, remove the chuck and clamp the work in place.
- h. When grinding or polishing, always wear safety goggles.
- i. Never operate a machine from which the guards have been removed.
- j. Do not let molten solder come in contact with wet metal because the solder will blow up in your face and eyes.

Note: Only fools solder without wearing safety glasses.
- k. Do not let soldering acid get on your skin or in your eyes because it can cause serious injury.
- l. NEVER NEVER use oil near oxyacetylene welding equipment; the interaction of oxygen and oil can cause a violent explosion.
- m. Wear cutting goggles when working with oxyacetylene cutting equipment.

Information Sheet

6. Steps in lifting safely

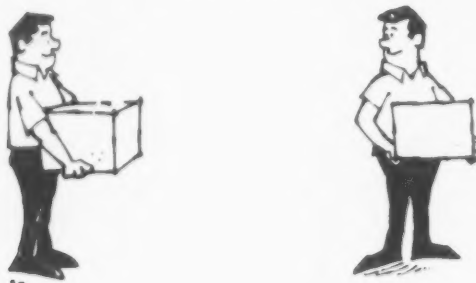
- a. Size up the load to make sure you can safely handle it alone, and then place your feet close to the object and about 12" apart.



- b. Bend your knees, get a good hand hold, then use both legs and back muscles to lift the load straight up as you push with your legs and keep the load close to your body.

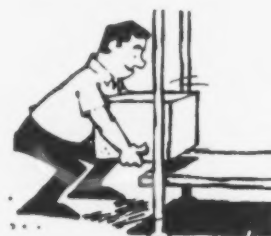


- c. Do not turn or twist until you have the load lifted into a carrying position, and then move your feet to turn your body as you check your path of travel to make sure it's clear.



Information Sheet

- d. Lower the load by bending your knees, and remember to store heavy objects at least 12" off the floor.



7. **Special lifting rules for appliance repair**

- a. Heavy appliances such as washers and dryers should always be transported on an appliance dolly and securely tied with a restraining strap.

Caution: Side rails on a good appliance dolly should be padded, and if they are not, portable padding should be used to avoid scarring the finish on the cabinet.

- b. An appliance flipper should always be used to turn heavy appliances because it will protect your back, avoid damage to the appliance, and protect a customer's floor.
- c. In cases where heavy appliances have to be loaded on a truck, always work with a helper unless the truck is equipped with a hydraulic tail gate lift such as a Tommy Lift.

8. **MSDS (Material Safety Data Sheet) information and its details**

Note: See Student Supplement 1.

- a. Chemical name—Lists the identity of the substance, the date that MSDS was prepared, name and address of the manufacturer, and usually a phone number for emergencies
- b. Hazardous ingredients/chemical identity--Includes names of substances in the chemical that might be dangerous, safe exposure limits, and common names for the chemical
- c. Physical characteristics--Describes usual or safe physical qualities such as how it looks or smells, boiling and melting temperatures, evaporation rates, how easily it dissolves, and how heavy it is compared to water
- d. Fire and explosion data—Identifies flash point, flammability, combustibility, and the best way to put out a fire involving that chemical

Information Sheet

- e. **Reactivity**--Describes what happens if this chemical comes in contact with certain conditions like heat, or chemicals like air, water, or others
- f. **Health hazards**--Lists ways the chemical might enter your body, symptoms of overexposure, and emergency first aid procedures
- g. **Usage, handling, and storage**--Describes how to clean up an accidental spill, leak, or release, including special precautions; tells how to handle, store, and dispose of chemical safely
- h. **Special protection and precautions**--Explains special personal protective equipment and other equipment to use when working with the chemical and extra health and safety information not covered in other sections

Note: A company may design its own MSDS, and the information above may be presented in an order other than the order shown, but all the information should be on the MSDS.

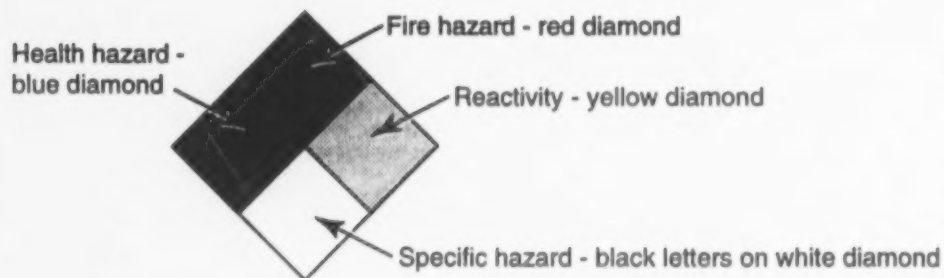
9. **Problems and health effects of hazardous chemicals**

- a. Hazardous chemicals can enter the body by way of ingestion, absorption, or inhalation.
- b. Ingestion means the chemical is accidentally swallowed or eaten from food that has been touched by someone contaminated with the chemical.
- c. Absorption means the chemical has contacted the skin or eyes, and all types of acids and cleaning fluids are culprits in this form of entry.
- d. Inhalation means entry by breathing fumes, vapors, or gases, and this often happens to workers confined to small or poorly ventilated workplaces.
- e. Short term effects from a brief encounter with a hazardous chemical may cause a variety of responses such as pain, nausea, itching skin, burning eyes, headache, or vomiting.
- f. Long term effects from repeated or prolonged exposure to a hazardous chemical may cause a variety of disabling or fatal responses such as kidney damage, emphysema, sterility, or cancer.
- g. The long term effects are most dangerous because they may not show up until years after the exposure and at a time when their effects cannot be reversed; that is why it is important to observe precautions around all hazardous chemicals.

10. The diamond classification system for hazardous materials

- a. The diamond classification system for hazardous chemicals is used on containers that store and on vehicles that transport hazardous materials.
- b. The diamond coding system was devised by the National Fire prevention Association and uses a large diamond made up of four small diamonds that use position and color to indicate the type of hazard.

Diamond Location	Characteristic	Diamond Color
Left-hand diamond	Health hazard	Blue
Top diamond	Fire hazard	Red
Right-hand diamond	Reactivity	Yellow
Bottom diamond	Specific hazard	Black on white



- c. In addition to position and color, the diamond coding system uses the numbers 0 through 4 to indicate the severity of danger, ranging from 0 to identify normal, stable material to 4 to identify deadly materials.

Information Sheet

- d. Other specific hazards are identified with abbreviations or symbols.

Specific Hazard	Abbreviation or Symbol
Oxidizer	OXY
Acid	ACID
Alkali	ALK
Corrosive	COR
Use NO WATER	
Radiation hazard	

Examples:

Chemical #1

Chemical #2



Chemical # 1 presents a chemical rated hazardous because it will burn below 200°F and will exhibit a violent chemical change; use no water on this chemical.

Chemical #2 presents a chemical rated an extreme danger because it will burn below 73°F and may detonate in conditions of shock or heat.

11. Fire safety rules

- Report immediately anything that might be a potential fire hazard.
- Know the location and the proper operation of fire extinguishers and make sure they have been recently checked.
- Know where the nearest telephone is and make sure the number of the nearest fire department is listed on the phone, if other than 911.
- Know the procedure for evacuating the building and the location of all fire exits in case one or more exits may be blocked.

Information Sheet

- e. Smoke only at authorized times and in authorized areas and make sure cigarette butts are completely extinguished and properly discarded.
- f. Examine materials and equipment around the workplace to determine what types of fires might occur, then make sure available fire extinguishers are correct for the classes of fires that might occur.
- g. Isolate combustible materials in fire-resistant areas.
- h. Dispose of rubbish regularly.
- i. Conduct fire drills at regular intervals to make sure the alarm can be heard over shop noises, and that everyone knows evacuation routes, exits, and reassembly points.
- j. Do not stack anything in front of a fire extinguisher.
- k. Know where electrical and gas cut-offs are located so you can reach them quickly if an emergency demands.

12. Classes of fires and their causes

- a. Class A fires--Result from ordinary combustibles such as wood, paper, and cloth
- b. Class B fires--Result from flammable liquids such as gasoline, oil, paint, solvents, and grease
- c. Class C fires--Result from electrical wires, switches, and motors

Note: See Student Supplement 2 to enhance objectives 12, 13, and 14.

13. Types of fire extinguishers and their recommended uses

- a. Foam--Recommended only for Class A and Class B fires
- b. Soda acid--Recommended only for Class A fires
- c. Pump tank--Recommended only for Class A fires
- d. Multi-purpose dry chemical--Recommended for all classes of fires
- e. Ordinary dry chemical--Recommended for only Class B and Class C fires
- f. Halon--Recommended for only Class B and Class C fires

Note: Because of its expense, Halon should not be used on a Class A fire, and although it can be used on a Class B fire, it is usually reserved for Class C use around computer rooms or high-density electronic installations because it leaves no residue to damage sensitive parts or components.

Information Sheet

14. Types of fire extinguishers and their recommended operations

- a. Foam—Allow foam to fall lightly onto the fire, not directly into the fire, especially a burning liquid

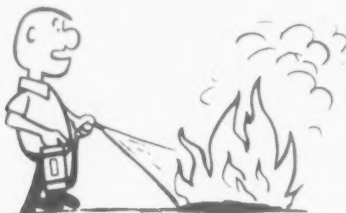


- b. Carbon dioxide—Get as close to the fire as possible, and direct the discharge at the edge of the flames and work gradually forward and upward

Note: A Halon fire extinguisher should be used in the same way as a carbon dioxide extinguisher.

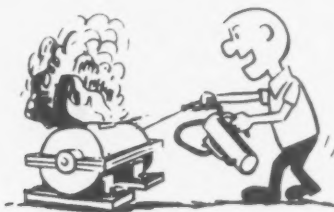


- c. Soda acid and pump tank—Direct the stream at the base of the flames



Information Sheet

- d. Dry chemical—Direct the stream at the base of the flames, and then directly at material left burning



15. Special safety requirements for appliance repair

- a. Working with washers, dishwashers, and garbage disposers exposes technicians to electrical/water hazards that demand special attention.
- b. Always make sure the appliance is unplugged or removed from its power source before working with water lines or hoses.

Note: Undercounter dishwashers, garbage disposers, and many ranges usually require tripping a breaker or removing a fuse.

- c. When loosening water-carrying connections, hold a shop towel around the connection so water won't spray onto adjacent electrical components.
- d. Drain water into a pan, but do not permit water to drain onto a floor, especially in a customer's home.

Note: Some shop areas have direct drain facilities, but on a house call, water on a floor is unsightly and dangerous.

- e. When testing a water-carrying connection that has just been made up, hold a shop towel around it until you know it doesn't leak.
- f. Tools exposed to water should be thoroughly dried and lubricated before putting them away.
- g. Never set electrical test instruments on a wet surface.
- h. Make sure all equipment that you install or work on is properly grounded.
- i. Use compressed gases with care.
- j. Never direct a compressed air hose in the direction of another worker.

Information Sheet**16. Special rules for eye protection**

- a. Safety glasses should be worn at all times in the shop.
- b. Safety goggles with proper shaded lenses must be worn when working with oxyacetylene cutting equipment.
- c. Safety goggles should be worn when soldering.
- d. A face shield should be worn when grinding.
- e. Any form of eye protection worn should be kept clean so it will not impair the view of materials or the work area.

17. Ways to recognize shock

- a. Skin is pale or bluish.
- b. Skin may be moist and clammy, even cold to the touch.
- c. Victim feels weak.
- d. Pulse is rapid and weak.
- e. Breathing rate is fast and irregular.
- f. Victim may be confused or incoherent.

18. Steps in treating shock

- a. Notify supervisor or instructor IMMEDIATELY.
- b. DO NOT DELAY immediate first aid treatment; it can be life saving.
- c. Eliminate the causes of shock, control bleeding, or administer artificial respiration if the victim is not breathing.
- d. Keep victim lying down with feet slightly elevated.

Caution: If the victim has sustained a head or chest injury, do not elevate the feet. Leave the victim lying flat, and when in doubt about the nature of the wound, leave the victim lying flat.

- e. Cover the victim to retain body heat, but do not make victim sweat.
- f. Give no liquids or food to a shock victim.

Information Sheet

19. First aid for victims of electrical shock

- a. Remove the victim from the electrical source or cut off the electrical source as quickly as possible.
 - (1) In a shop area where electrical breakers can be reached quickly, shut off power before touching victim.
 - (2) In any situation where the power cannot be shut off, use a dry stick, a rope or leather belt, or a coat or blanket to separate the victim from the source of electricity.

Note: See Student Supplement 3.

- b. Have someone call for medical assistance immediately.
- c. Check victim's breathing and heartbeat:
 - (1) If pulse is present, but breathing has stopped, administer mouth to mouth resuscitation.
 - (2) If heartbeat has stopped, administer cardiopulmonary resuscitation but only if you have been properly trained.
- d. Treat for shock by keeping the victim warm with legs raised slightly above the level of the head.
- e. Treat for electrical burns by wrapping the burned area with sterile gauze, and as you treat for burns, cover your mouth with a handkerchief to keep germs away from the burns.
- f. Continue treatment until medical help arrives.

20. First aid guidelines for common workplace injuries

- a. Minor cuts should be cleaned with soap and water, rinsed, and covered with a dry, sterile dressing.
- b. Puncture wounds should be cleaned with soap and water, rinsed, then cleaned and rinsed again before covering with a dry, sterile dressing.
- c. Slivers and splinters that do not penetrate deeply should be treated as puncture wounds, but splinters that penetrate deeply should be removed by a doctor.
- d. Regardless of severity, all cuts, punctures, and splinter injuries should be treated immediately to avoid infection.
- e. Depending on the cause of the cut, puncture, or splinter wound, it is usually wise to consider tetanus a hazard.

Information Sheet

- f. Report all cuts, punctures, splinter wounds, and abrasions to your supervisor or instructor.

21. First aid guidelines for workplace burns

- a. Always treat the victim for shock.
- b. In the case of a chemical burn, wash off the chemical with large quantities of running water and cut clothing off the affected area.
- c. In the case of thermal burns, cut away clothing from the area of the burn, but do not try to remove material that adheres to the burn.
- d. With all burns, apply a thick, sterile dressing to prohibit air from reaching the burn.

22. Steps for controlling bleeding

- a. Place a compress of sterile gauze or the cleanest available material directly over the bleeding site.
- b. Press firmly with fingers or palm of one hand.
- c. Elevate the bleeding parts above the heart level unless there is evidence of a fracture.
- d. If blood soaks through the first compress, place another compress on it, but do not remove the first compress.
- e. Secure compress with a pressure bandage.
- f. Treat for shock.
- g. If there is a severe life-threatening hemorrhage, AND ONLY AS A LAST RESORT, apply a tourniquet.

23. Pressure points for stopping bleeding

- a. Bleeding from the front of the face can often be controlled by pressing the facial artery.
- b. Bleeding from the armpit, or sometimes the entire arm, can often be controlled by pressure on the subclavian artery.
- c. Bleeding from an arm can often be controlled by pressure on the brachial artery.

Information Sheet

- d. Bleeding from a leg can often be controlled by deep pressure on the femoral artery.

Note: See Student Supplement 4

24. First aid guidelines concerning first aid for eye injuries

- a. Every eye injury should receive immediate first aid attention.
- b. Notify your supervisor or instructor immediately.
- c. For an apparent minor object in the eye, have the person wink several times. If the tears produced by winking do not remove the object, assume that the object is imbedded and use the following procedure:
 - (1) Have the victim close his or her eyes.
 - (2) Put a piece of moist cotton over the closed lid.
 - (3) Place a bandage over the cotton.
 - (4) Get the victim to a doctor as soon as possible.
- d. When the eyeball has been obviously scratched or penetrated, apply a sterile dressing, a bandage *loosely*, and get medical help immediately.
- e. Never permit the victim of an eye injury to rub his or her eye.
- f. When in doubt about any eye injury, seek the most immediate medical attention whether it's on the job or in the classroom.
- g. Even though damage may be confined to one eye, it is sometimes best to bandage both eyes with a sterile dressing so the victim will not have a tendency to move the damaged eye.
- h. For chemical or acid splashes, flush the eyes repeatedly at an eye-flushing station or use a bottled, portable flushing solution, then seek immediate medical assistance.

25. General guidelines for first aid emergencies

- a. Never hesitate to administer first aid when it is needed.

Caution: Resuscitation procedures require special training and should not be practiced by untrained persons.

- b. Always have a reason for what you do.

Information Sheet

- c. Reassure the injured person that everything possible is being done.

Note: Hearing the concerned voice of a co-worker is psychologically comforting to an injured person and can actually lessen the degree of shock.

- d. Make accurate notes about the accident including name of victim, time, place, cause or nature of the accident, and any first aid that was administered.
- e. Do not notify the victim's family because this is the responsibility of the school, the jobsite supervisor, or the medical facility.
- f. Report all accidents and injuries to your instructor or jobsite supervisor, no matter how minor they may seem to be.
- g. File a complete accident report and submit a copy to the proper persons.

Note: See Student Supplement 5.

Safety and First Aid Unit 2

Student Supplement 1—MSDS Information

SPARTAN CHEMICAL CO., INC. MATERIAL SAFETY DATA SHEET

SECTION I: PRODUCT INFORMATION

PRODUCT NAME OR NUMBER (as it appears on label)

NABC PLUS IV

MANUFACTURER'S NAME

Spartan Chemical Co., Inc.

EMERGENCY TELEPHONE NO.

419/531-5551

ADDRESS (NUMBER, STREET, CITY, STATE AND ZIP CODE)

110 N. Westwood Ave., Toledo, OH 43607

NFPA RATINGS:	HMS RATINGS:
HEALTH-1 FIRE-0 REACT-0	HEALTH-1 FIRE-0 REACT-0 PERS. PROT.-B

SECTION II: HAZARDOUS INGREDIENTS

CAS REGISTRY NO.	%W	CHEMICAL NAME(S)	TABLE Z-1-A			CARCINOGEN
			TWA mg/M ³	STEL mg/M ³	CEILING mg/M ³	

77-92-9

1-5

Citric acid

--- Not established ---

No

SECTION III: PHYSICAL DATA

BOILING POINT

200-210°F

VAPOR PRESSURE

18 MM Hg @ 75°F

VAPOR DENSITY (AIR = 1)

Unknown

SOLUBILITY IN WATER

Complete

pH

1.5 - 2.0

SPECIFIC GRAVITY (H₂O = 1)

1.01

PERCENT SOLID BY WEIGHT

5-10

EVAPORATION RATE (but. sec. = 1)

<1

APPEARANCE AND ODOR

Blue viscous fluid,

floral odor

IS MATERIAL: (LIQUID) SOLID

GAS PASTE POWDER

SECTION IV: FIRE & EXPLOSION HAZARD DATA

FLASH POINT - None

METHOD USED - ASTM - D56

FLAMMABLE LIMITS - n/a

EXTINGUISHING MEDIA - n/a

SPECIAL FIRE FIGHTING PROCEDURES - None

UNUSUAL FIRE AND EXPLOSION HAZARDS - None known

BEST COPY AVAILABLE

Courtesy Spartan Chemical Co., Inc.

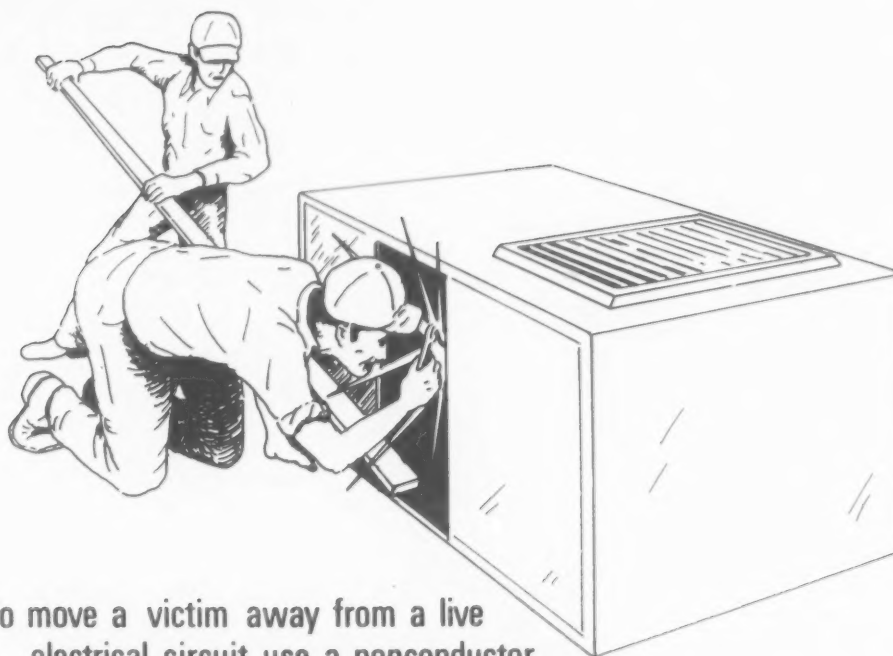
Safety and First Aid Unit 2

Student Supplement 2—Fire Safety

KIND OF FIRE		APPROVED TYPE OF EXTINGUISHER						
DECIDE THE CLASS OF FIRE YOU ARE FIGHTING. . . ↓	... THEN CHECK THE COLUMNS TO THE RIGHT OF THAT CLASS →	MATCH UP PROPER EXTINGUISHER WITH CLASS OF FIRE SHOWN AT LEFT						
		FOAM Solution of Aluminum Sulphate and Bicarbonate of Soda	CARBON DIOXIDE Carbon Dioxide Gas Under Pressure	SODA ACID Bicarbonate of Soda Solution and Sulphuric Acid	PUMP TANK Plain Water	GAS CART-RIDGE Water Expelled by Carbon Dioxide Gas	MULTI-PURPOSE DRY CHEMICAL	ORDINARY DRY CHEMICAL
A  CLASS A FIRES USE THESE EXTINGUISHERS  ORDINARY COMBUSTIBLES • WOOD • PAPER • CLOTH ETC.								
			X					X
B  CLASS B FIRES USE THESE EXTINGUISHERS  FLAMMABLE LIQUIDS, GREASE • GASOLINE • PAINTS • OILS, ETC.								
				X	X	X		
C  CLASS C FIRES USE THESE EXTINGUISHERS  ELECTRICAL EQUIPMENT • MOTORS • SWITCHES ETC.								
		X		X	X	X		

**Safety and First Aid
Unit 2**

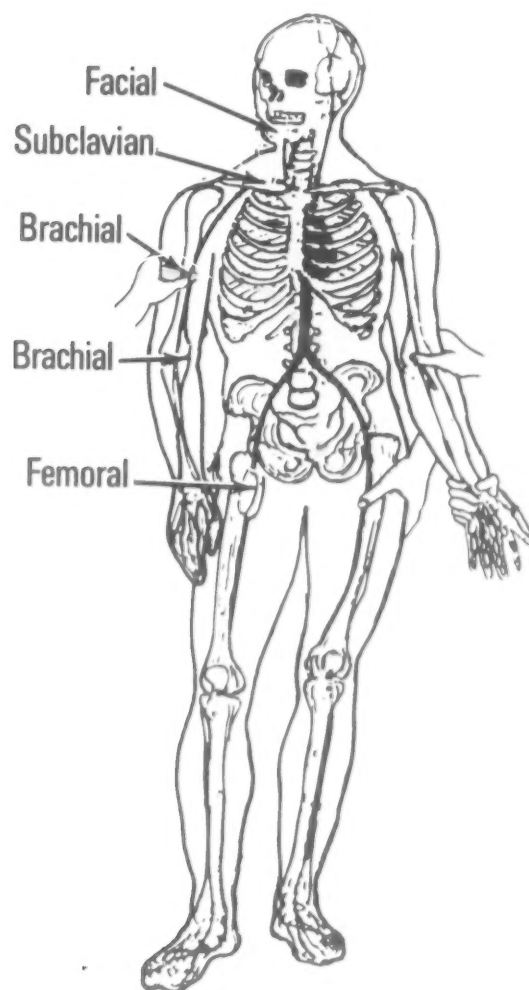
Student Supplement 3—Electrical Emergency Rescue Procedure



To move a victim away from a live electrical circuit use a nonconductor such as a long dry wooden or plastic pole.

Safety and First Aid
Unit 2

Student Supplement 4—Pressure Points for Checking Bleeding



STANDARD STUDENT ACCIDENT REPORT FORM

Information on ALL Accidents

National Safety Council Form School 10
Rev. 10/19/1950

**Safety and First Aid
Unit 2****Assignment Sheet 1—Select Proper First Aid Procedures**

Name _____ Overall Rating _____

Evaluation Criteria	Rating
Number of first items correctly answered	_____
Number of second items correctly answered	_____
Total number of correct answers	_____

Directions: The following statements present situations in which first aid is required; read the statements carefully and provide answers as indicated.

- A. A fellow student has suffered a minor cut working with a washer; you have cleaned the cut with mild soap and water and rinsed the cut off, but the cut still looks as if it might have dirt on it.
1. What would you do next? _____
 2. What would you do after that? _____
- B. A fellow student complains of a splinter in her wrist; you examine it and find that the splinter is deeply embedded.
1. What would you use to remove the splinter? _____

 2. What would you do next? _____
- C. A fellow student has just had a hard bump on the head; a few moments later he complains of feeling weak; you reach over to help him to a chair and notice that his skin feels moist and almost cold to touch.
1. What is probably wrong? _____
 2. What would you do? _____
- D. A fellow student has suffered a bad cut; you have cleaned the cut and applied a compress to it, but in a few minutes the compress is bloody and messy.
1. Should you remove the blood-soaked compress? _____

Assignment Sheet 1

2. What would you do next? _____
- E. A fellow student has suffered an eye injury, and it appears that a small piece of metal may be embedded in the eyeball.
1. What would you do first? _____
2. What would you do next? _____
- F. A fellow student has suffered an eye injury, nothing appears to be embedded in the eyeball and the rest of the eye appears to be free of any foreign matter, but the student complains of great pain.
1. What would you do if this happens in the school shop? _____

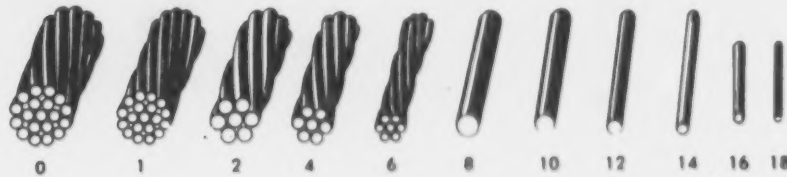
2. What would you do if this happens on the job? _____

- G. You have just assisted in administering first aid to a fellow worker with a bad cut; the cut has been cleaned, the compress that was applied is doing a good job, and everything is under control.
1. What should you do next? _____

2. What should you do after that? _____

Information Sheet

- b. The AWG number grows smaller as the size of the wire increases.



- c. The major insulation types required around major appliances are:
- (1) RHW--Moisture and heat-resistant rubber for dry and wet locations where operating temperatures do not exceed 167°F
 - (2) THW--Moisture and heat-resistant thermoplastic for dry and wet locations where operating temperatures do not exceed 194°F
 - (3) AA--A special wire for electric ranges because it has a braided asbestos covering and can operate at temperatures up to 392°F
- d. When reading wire sizes, the first number is the AWG size and the second number indicates how many conductors are in the wire.
- Example: 10/3 is a 10-gauge wire with 3 conductors.
- e. The maximum amperage a wire can safely carry is known as ampacity, and low ampacity wires should never be used for high ampacity applications.

AWG#	Ampacity
14	15
12	20
10	30
8	45
6	65
4	85
2	115
1	130
0	150
00	175
000	200

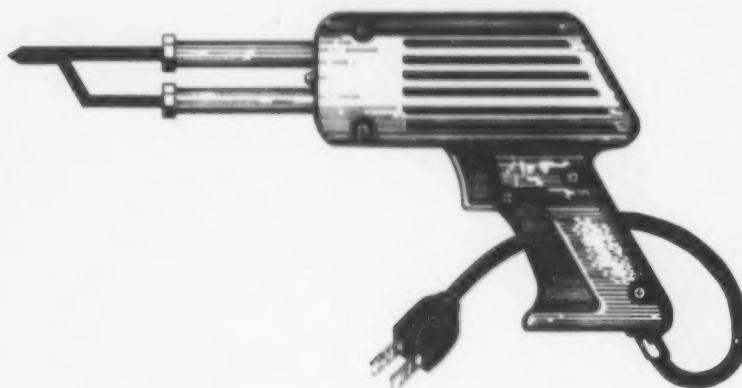
- f. Never replace an AWG wire with a smaller wire because it could cause a malfunction and create a fire hazard.

Information Sheet

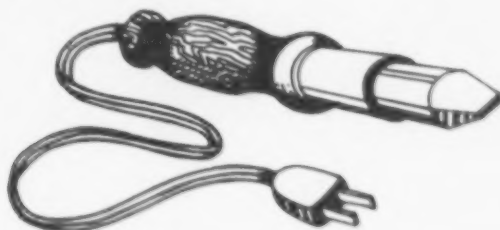
A receptacle for an electric range has a #8 AWG wire for ground and #6 AWG wires for both the hot leads; using #10 wire for the connection would not meet the NEC code, but #10 AWG wire is acceptable on a dryer receptacle because of the lower amperage a dryer demands.

15. Soldering tools

- a. A 150 to 250 watt soldering gun is recommended for connectors and circuits rated 30 to 50 amps or greater.



- b. Large soldering irons of 40 to 150 watts are suitable for connectors and circuits rated 10 to 30 amps.



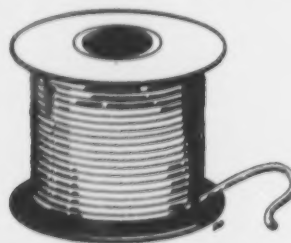
- c. A pencil iron rated 20 watts or less may be required for special applications such as printed circuit boards or where space will not permit a larger iron.



- d. Soldering poses burn hazards, but the greater danger is potential eye damage, so always wear safety glasses when soldering.

16. Resin-core solder and its characteristics

- a. The type of solder used most often around electrical connections is 40/60 resin-core solder.
- b. The 40/60 means the solder is an alloy of 40% tin and 60% lead.
- c. The flux required to clean metal and promote fusion is placed inside the core of resin-cored solder.
- d. Resin-core solder comes in handy rolls that are convenient to store and carry.



- e. Resin-core solder is noncorrosive and suitable for almost all work around major appliances.
- f. When using resin-core solder, clean surface(s) to be soldered, apply heat to the surfaces, and then run the strand of solder over the heated surface(s).

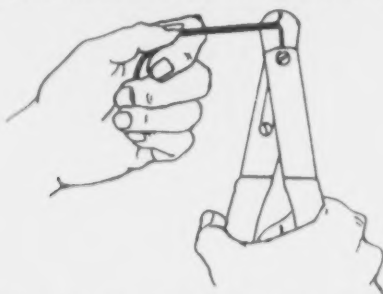
17. Solid wire solder and its characteristics

- a. Solid wire solder is a popular 40/60 alloy for use in sweating or swaging joints of tubing.
- b. Because solid wire solder has no flux core, a paste flux must be used with it.
- c. The procedure for using solid wire solder is:
 - (1) clean surfaces to be soldered,
 - (2) apply soldering flux to both surfaces,
 - (3) apply heat to the parts to be soldered, not to the solder itself, and
 - (4) apply the solder to the heated parts and allow it to melt onto the parts.

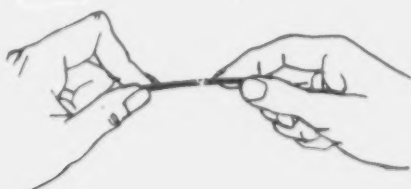
Information Sheet

18. Steps in wire stripping

- a. Place the wire in the proper slot in the wire stripper and work the stripper back and forth until a cut is made around the entire insulation.



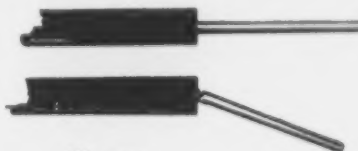
- b. Hold the wire tight with one hand and use the other hand to gently move the insulation back and forth until the cut breaks clean and unwanted insulation can be pulled off.



- c. Taper the insulation with a knife to increase the wire's flexibility because straight cut insulation creates a force point that can cause a wire to break.



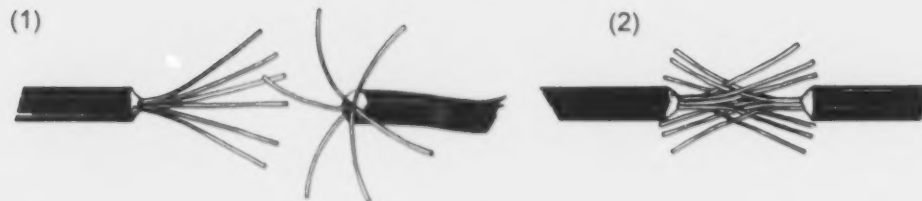
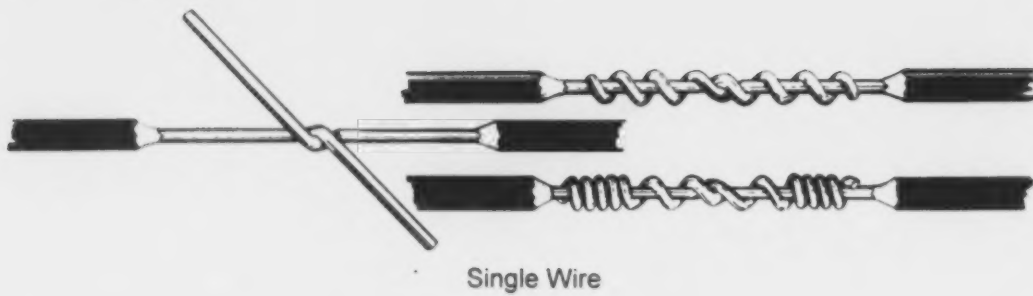
Right



Wrong

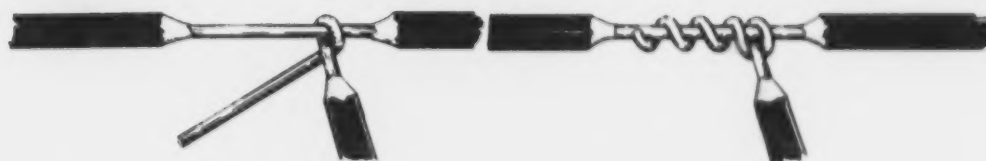
19. Types of splices

a. Simple splice



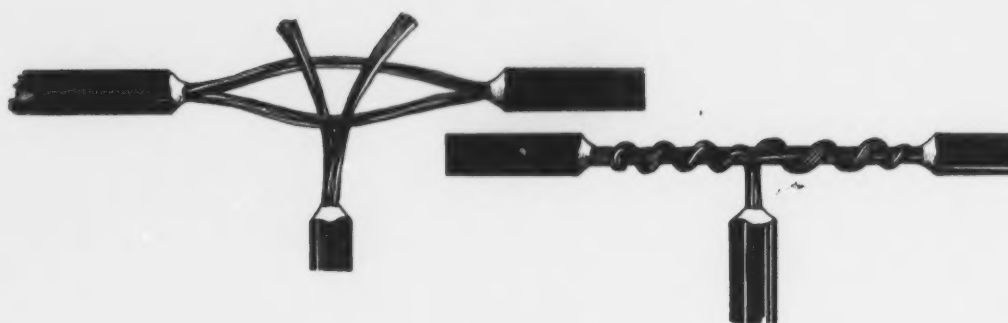
Stranded Wire

b. Simple tap



Single Wire

Information Sheet



Stranded Wire

c. Pigtail splice



(1)



Single Wire

(2)



(3)



(4)



Single Wire to Stranded Wire

d. Hook splice



20. Guidelines for connections at screw terminals

- a. Wire should be attached at a screw terminal so that the loop lies in the direction the screw turns.



Right



Wrong

- b. Wire should loop the screw a little less than one full turn, but excessive loops are not recommended.

21. Guidelines for good soldered splices

- a. Wires to be spliced must be bright and clean at the point of connection.
- b. Connecting points must be tight so solder will solidify without wire movement.



- c. Wire should be coated with electric soldering paste, and then soldered so the solder melts and flows into every crevice of the splice.



- d. Entire splice area should be covered with water-proof plastic tape.



22. Guidelines for using soldering connectors and terminals

- a. Solderless connectors should be used according to their color codes, and a connector for a lighter gauge should never be used on a wire of a heavier gauge.
- b. Screw-on connectors work well on pigtail splices, and they require no taping because they are made of insulating materials.



Information Sheet

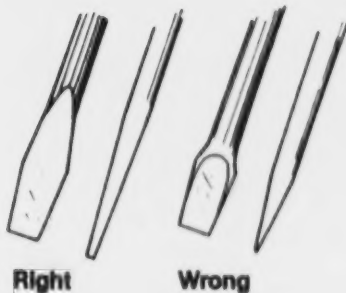
- c. Crimp-on terminal lugs should not leave a gap between the insulation and the lug, and if there is a gap, a plastic sleeve should be added to cover the bare wire.



23. Proper care and use of hand tools

a. Screwdrivers

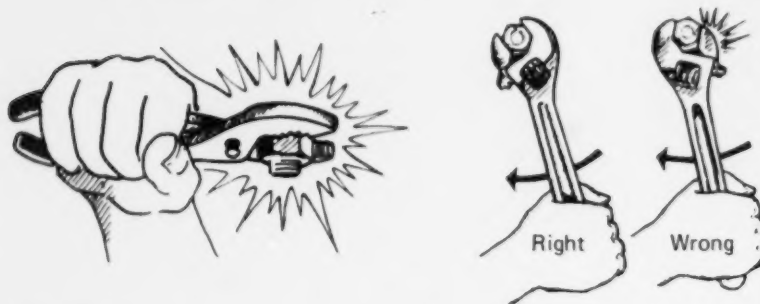
- (1) Do not hammer or pry with screwdrivers.
- (2) Worn Phillips screwdrivers should be discarded, but flat blade screwdrivers can be useful as long as the tip can be reground square.



b. Wrenches and pliers

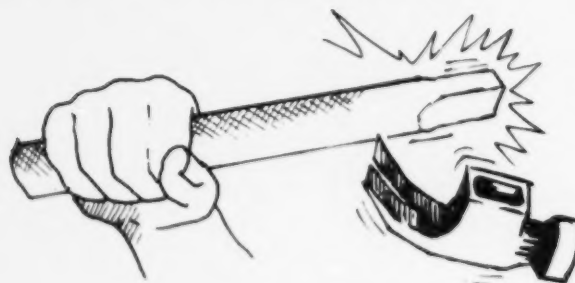
- (1) Do not hammer on wrenches or hammer with wrenches.
- (2) Use adjustable wrenches so that the large jaw is opposite the direction of force.
- (3) When pulling on an adjustable wrench, be careful not to hit yourself in the chest or head, and when pushing on an adjustable wrench, hold your hand palm-flat on the handle so you won't accidentally scar your knuckles.
- (4) Do not use pliers in place of a wrench, especially on brass fittings.

- (5) Use pliers with insulated handles when working around electrical circuits and components.



c. Hammers

- (1) Never use a hammer with a loose handle.
- (2) Use all hammers for their intended purpose.

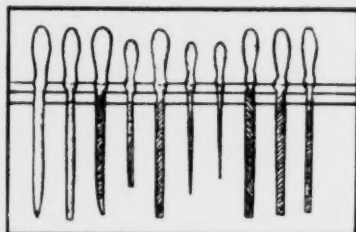


d. Punches, chisels, and files

- (1) Keep chisel cutting edges sharp.
- (2) Keep chisel heads properly dressed, and never strike a chisel that has a mushroomed head.
- (3) Files become dull if stacked in a drawer, so hang them up.

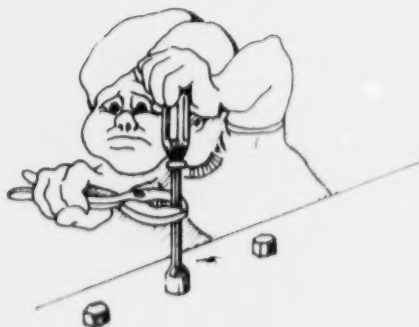
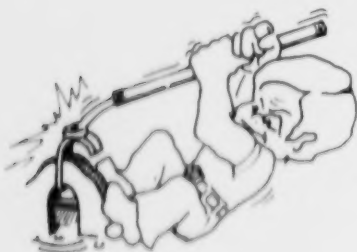
Information Sheet

- (4) Do not hammer or pry with a file because they are brittle and break easily.



e. Socket sets and nut drivers

- (1) Do not use a cheater bar to gain greater leverage on the handle of a ratchet because it will strip the ratchet gears.
- (2) Do not use a cheater bar on a thin wall socket because the socket will break.
- (3) Nut drivers should be used for hand-tight nuts, bolts, and screws, but do not use pliers to increase leverage.



24. Guidelines for using other tools and equipment

- a. Cords for drop lights should not be run over by appliance dollies or placed where objects with metal edges may be placed on them.
- b. Handle levels with care because once they are dropped they are usually inaccurate.
- c. Do not apply too much pressure on a hex wrench or it may break or round out the socket in the set screw.

Information Sheet

- d. Never use oxyacetylene equipment without proper instruction or without permission.
- e. Keep safety glasses in a case when they are not in use so they'll stay clean.

Note: If someone had to take time to clean a pair of safety glasses, they might have a tendency just to forget them.

- f. Never point a compressed air nozzle at another person, and never use compressed air when it might spray dirt or metal particles at someone nearby.

25. Eye protection

- a. Wear safety glasses at all times in the shop area.
- b. Blow compressed air away from you when using it for cleaning.
- c. Wear a face shield when working with grinding tools.
- d. If you get cleaning solvent on your hands, wash them with soap and water to avoid the possibility of accidentally rubbing your eyes.
- e. Know the location of the nearest eye flush station.

Tools, Materials, and Test Instruments
Unit 6

Student Supplement 1—Basic Hand Tools



Adjustable Pliers



Needle-nose Pliers



Lineman's (sidecutting) Pliers



Slip-Joint Pliers



Wire Strippers
(Electrician's 6-in-1 tool)



Locking Pliers



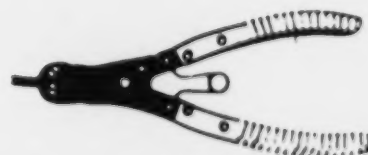
Standard Screwdriver Set



Phillips Screwdriver Set



Nut Driver



Internal Snap-Ring Pliers



External Snap-Ring Pliers

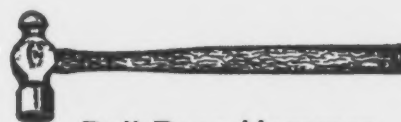
Tools, Materials, and Test Instruments
Unit 6

MAR-181

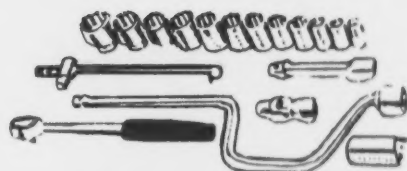
Student Supplement 2—More Basic Hand Tools



Aviation Snips



Ball Peen Hammer



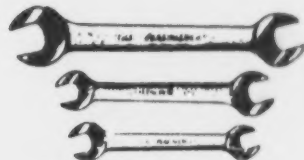
Socket Set and Ratchet



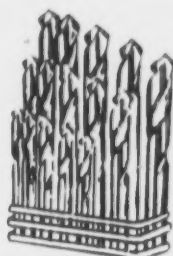
Pipe Wrench



Adjustable Wrench



Open End Wrenches



Drill Bits



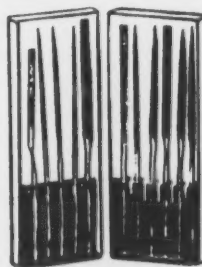
Drill



Chisel



Punch



Files

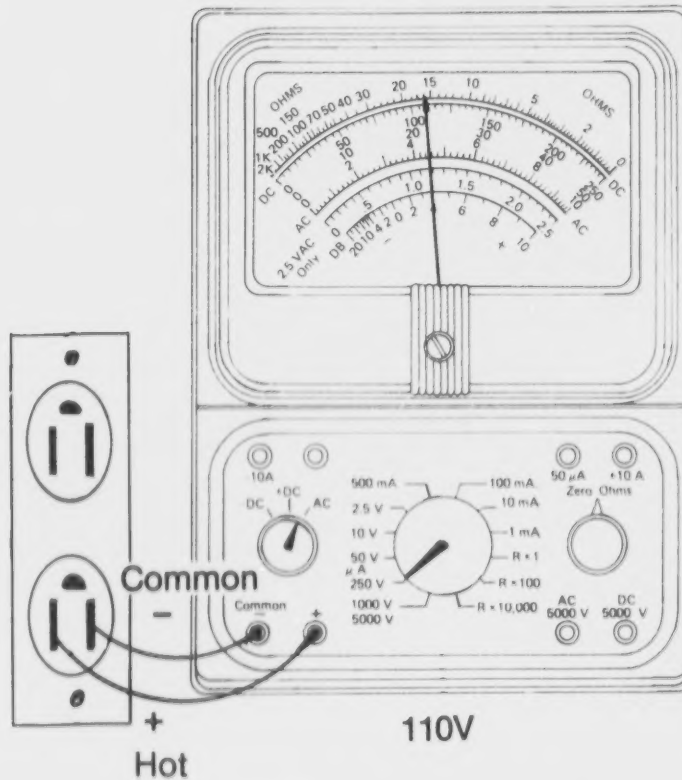


Hex Wrenches

Tools, Materials, and Test Instruments
Unit 6

MAR-183

Student Supplement 3—Measuring Voltage at a Receptacle

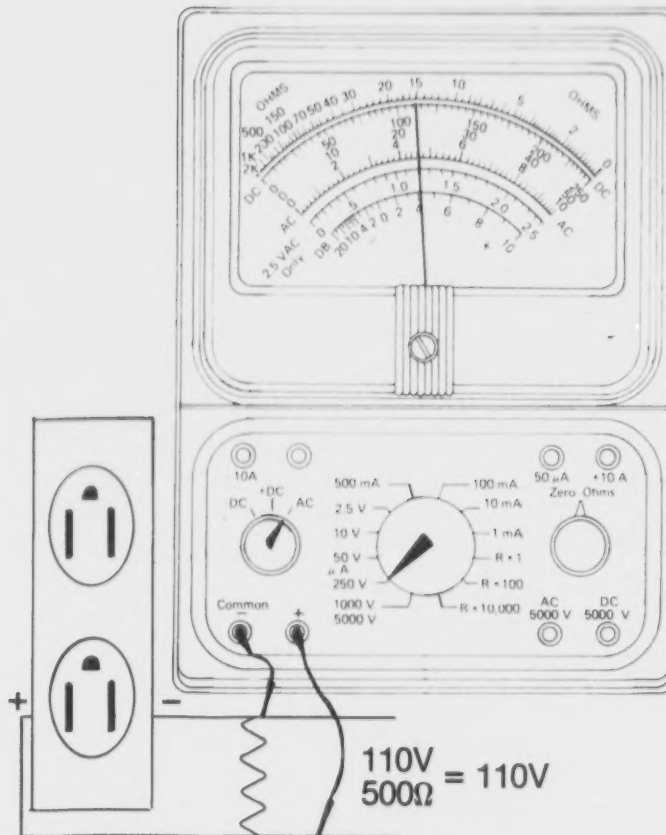


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Tools, Materials, and Test Instruments
Unit 6

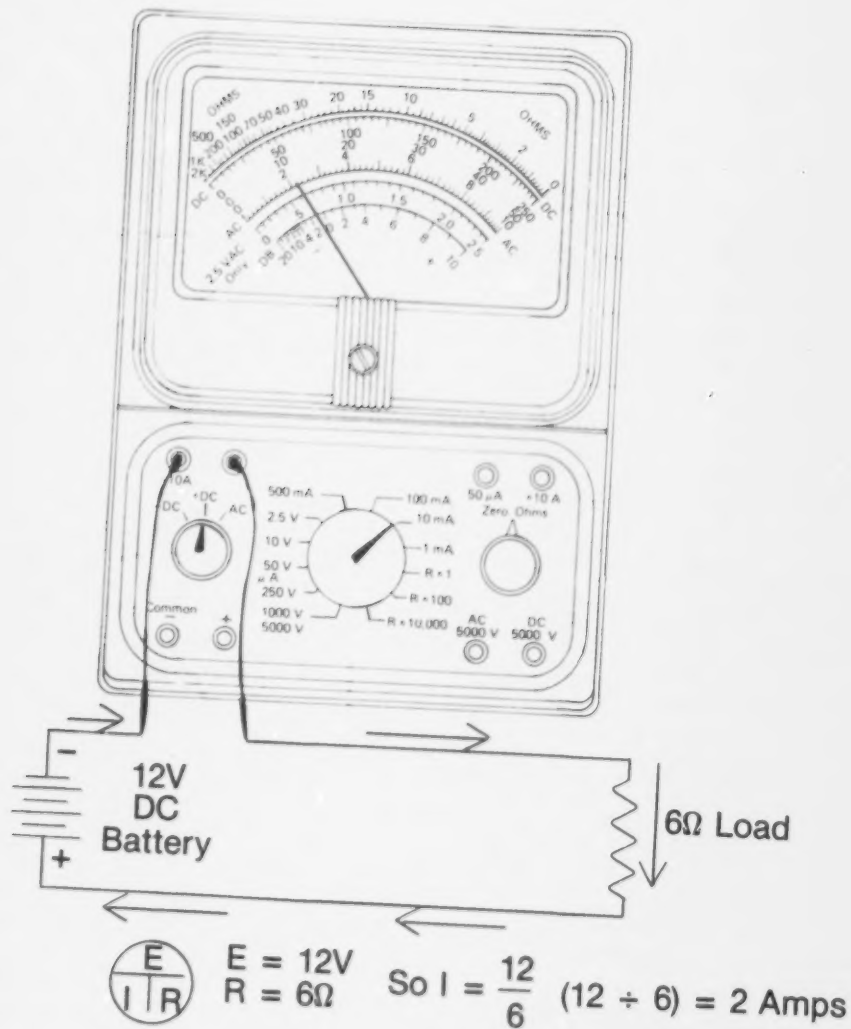
MAR-185

Student Supplement 4—Measuring Voltage in a Parallel Circuit



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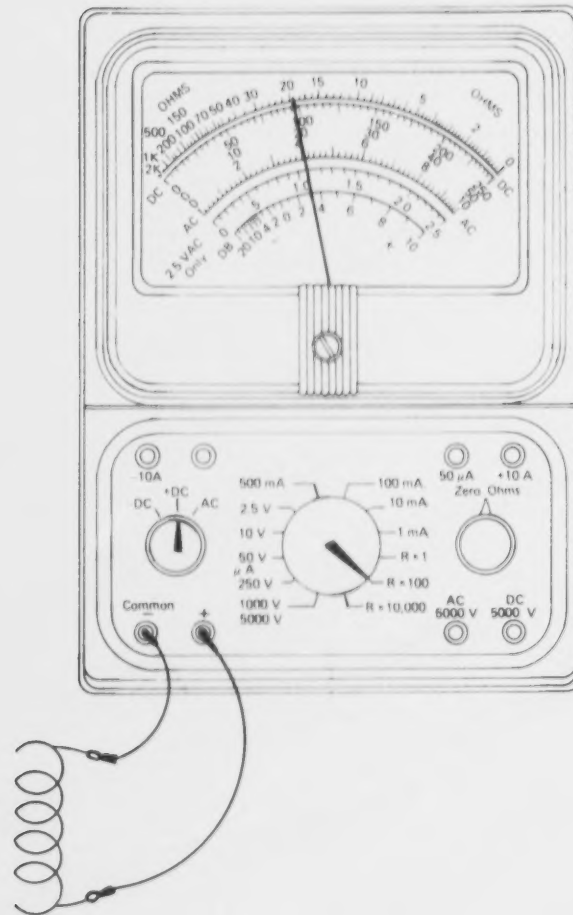
Student Supplement 5—Measuring Amperage in a Circuit



Tools, Materials, and Test Instruments

Unit 6

Student Supplement 6—Measuring Resistance in a Coil



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Tools, Materials, and Test Instruments
Unit 6

Assignment Sheet 1—Identify Selected Tools

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Number of Identifications attempted	_____
Number of correct identifications	_____

Directions: Your instructor has prepared a display of tools that are each tagged with a number. Examine the tools and write the name of each tool beside the correct number. Add more numbers as needed.

- | | |
|-----------|-----------|
| 1. _____ | 16. _____ |
| 2. _____ | 17. _____ |
| 3. _____ | 18. _____ |
| 4. _____ | 19. _____ |
| 5. _____ | 20. _____ |
| 6. _____ | 21. _____ |
| 7. _____ | 22. _____ |
| 8. _____ | 23. _____ |
| 9. _____ | 24. _____ |
| 10. _____ | 25. _____ |
| 11. _____ | 26. _____ |
| 12. _____ | 27. _____ |
| 13. _____ | 28. _____ |
| 14. _____ | 29. _____ |
| 15. _____ | 30. _____ |

Tools, Materials, and Test Instruments
Unit 6

MAR-193

Job Sheet 1—Test Electrical Receptacles for Correct Voltage

Name _____ Attempt Number _____

Date _____ Overall Rating _____

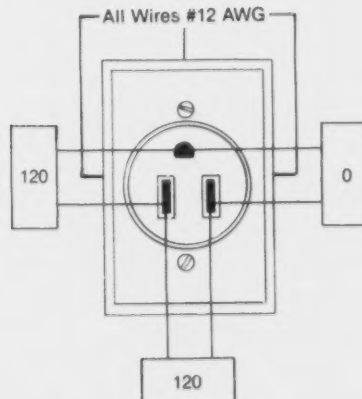
Evaluation Criteria	Rating
120V receptacle correctly tested and recorded	_____
240V range receptacle correctly tested and recorded	_____
240V dryer receptacle correctly tested and recorded	_____

A. Tools and materials

Wall receptacle with 120V supply
Wall receptacle for 240V range supply
Wall receptacle for 240V dryer supply
VOM
Pencil and paper
Safety glasses

B. Routine 2—Checking a 120V receptacle

- ☐ 1. Put on safety glasses and set the VOM to measure voltage at 250V.
- ☐ 2. Make sure the selector switch is set for AC.
- ☐ 3. Place one VOM test lead into each of the slotted openings in the receptacle.

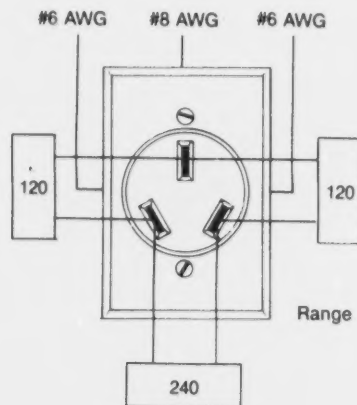


Job Sheet 1

- ☐ 4. Check your meter and record the reading _____.
- ☐ 5. Place one VOM lead in the left slotted opening and the other VOM lead in the round hole at the top of the receptacle.
- ☐ 6. Check your meter and record the reading _____.
- ☐ 7. Place one VOM lead in the right slotted opening and the other VOM lead in the round hole at the top of the receptacle.
- ☐ 8. Check your meter and record the reading _____.
- ☐ 9. Compare the reading in Step 8 with the reading from Step 6.
- ☐ 10. Have your instructor check your findings.
- ☐ 11. Make all voltage checks again if your findings vary at all from the values shown in the Routine 1 illustration.

C. Routine 2—Checking a 240V range receptacle

- ☐ 1. Leave the VOM set to measure 250V and the range selector set at AC.
- ☐ 2. Place one VOM test lead into each of the outside slotted openings in the receptacle.



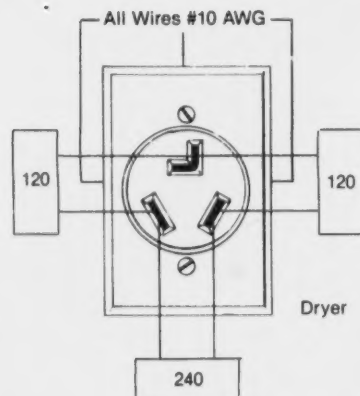
- ☐ 3. Check your meter and record the reading _____.
- ☐ 4. Place one VOM lead into the left slotted opening and the other VOM lead in the center slotted opening.
- ☐ 5. Check your meter and record the reading _____.

Job Sheet 1

- ☐ 6. Place one VOM lead into the right slotted opening and the other VOM lead in the center slotted opening.
- ☐ 7. Check your meter and record the reading _____.
- ☐ 8. Compare the reading in Step 7 with the reading from Step 5.
- ☐ 9. Have your instructor check your findings.
- ☐ 10. Make all voltage checks again if your findings vary at all from the values shown in the Routine 2 illustration.

D. Routine 3—Checking a 240V dryer receptacle

- ☐ 1. Leave the VOM set to measure 250V and the range selector set at AC.
- ☐ 2. Place one VOM lead into each of the outside slotted openings in the receptacle.



- ☐ 3. Check your meter and record the reading _____.
- ☐ 4. Place one VOM lead into the left slotted opening and the other VOM lead in the center L-shaped slot.
- ☐ 5. Check your meter and record the reading _____.
- ☐ 6. Place one VOM lead into the right slotted opening and the other VOM lead into the center L-shaped slot.
- ☐ 7. Check your meter and record the reading _____.
- ☐ 8. Compare the reading in Step 7 with the reading from Step 5.
- ☐ 9. Have your instructor check your findings.

Job Sheet 1

- ☐ 10. Make all voltage checks again if your findings vary at all from the values shown in Routine 3 illustration.
- ☐ 11. Discuss with your instructor the differences in the wire gauges used for each of the receptacles checked.
- ☐ 12. Clean up area and return tools and materials to proper storage.

Comments: _____

Tools, Materials, and Test Instruments
Unit 6

**Job Sheet 2—Use a Clamp-On Ammeter to Test for High and Low Amperages
on a Fan Motor and a Light Bulb**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Clamp-on probe properly used over only one wire	_____
High amperage check made and recorded	_____
Low amperage check made and recorded	_____

A. Tools and materials

Fan motor or other acceptable motor
100W light bulb
Clamp-on ammeter
Pencil and paper
Safety glasses

B. Routine 1—Checking high amperage

- ☐ 1. Put on safety glasses and plug motor into power source.
- ☐ 2. Determine current-carrying conductor.

Note: If necessary check schematic.

- ☐ 3. Clamp ammeter probes over current-carrying conductor.

Note: Do not clamp probes over two or three wires, make certain they are clamped over only one conductor.

- ☐ 4. Set the rotary scale for the highest amperage scale first, then move down as necessary to make your reading.
- ☐ 5. Determine amp reading from proper scale and record the reading: _____.
- ☐ 6. Have your instructor check your work.

Job Sheet 2

C. Routine 2—Checking low amperage

- ☐ 1. Plug 100-watt light bulb into power source.

Note: Conductor lead to load should have enough play that it can be wrapped around one of the meter clamps.

- ☐ 2. Clamp ammeter probes over current-carrying conductor.
- ☐ 3. Set the rotary scale for the highest amperage scale first, then move down as necessary to make your reading.
- ☐ 4. Unclamp the probe and loop the conductor three times around one of the meter clamps.
- ☐ 5. Determine amp reading from the proper scale and record your reading: _____.
- ☐ 6. Divide reading by the number of loops (three) you made in the conductor.
- ☐ 7. Have your instructor check your work.
- ☐ 8. Clean up area and return tools and materials to proper storage.

Comments: _____

Tools, Materials, and Test Instruments
Unit 6

**Job Sheet 3—Make a Continuity Check of a Magnetic Control Assembly
From an Automatic Washer**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Check made with VOM at R x 1 scale on both solenoids	_____
Check made with VOM at R x 100 scale on both solenoids	_____
Meter deflections correctly recorded	_____
Readings compared with 525 ohms	_____

A. Tools and materials

Magnetic assembly from a Whirlpool/Kenmore washer
VOM
Pencil and Paper
Safety glasses

B. Procedure

- ☐ 1. Put on safety glasses
- ☐ 2. Place the magnetic assembly on a work bench.
- ☐ 3. Set the VOM at the R x 1 scale.
- ☐ 4. Place the VOM probes on the terminals of the right or left solenoid.
- ☐ 5. Note the meter deflection and record it below:

R x 1 _____

Note: If the deflection is too small to read, write none.

- ☐ 6. Set the VOM to the R x 100 scale.

Job Sheet 3

- ☐ 7. Note the meter deflection and record it below:

R x 100 _____

- ☐ 8. Check your finding to see how close it is to 525 Ω .

- ☐ 9. Repeat the procedure for the other solenoid, but start with the R x 100 scale.

- ☐ 10. Record your findings.

R x 100 _____

R x 1 _____

- ☐ 11. Have your instructor check your findings.

- ☐ 12. Clean up area and return tools and materials to proper storage.

Comments: _____

Tools, Materials, and Test Instruments
Unit 6

MAR-201

Job Sheet 4—Splice Electrical Conductors to Acceptable Service Standards

Name _____ Attempt Number _____

Date _____ Overall Rating _____

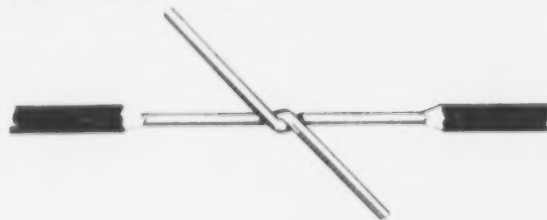
Evaluation Criteria	Rating
Simple splices correctly made, soldered, and taped	_____
Pigtail splices correctly made, soldered, and taped	_____
Tap splices correctly made, soldered, and taped	_____

A Tools and materials

Soldering gun
60/40 resin-core solder
Wire strippers
Utility knife
Needlenose pliers
Slip-joint pliers
Diagonal pliers
Diagonal cutters
Sponge
Plastic tape
Safety glasses

B Routine 1—Splicing and soldering simple splices

- ☐ 1. Select two pieces of single wire conductor.
- ☐ 2. Put on safety glasses and strip 2" insulation from the end of each conductor.
- ☐ 3. Bevel the end of each insulation cut.



Job Sheet 4

- ☐ 4. Twist conductors around each other with enough turns to insure a sturdy splice.



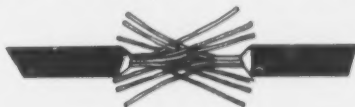
- ☐ 5. Place the spliced wires on a work bench.
- ☐ 6. Heat the soldering gun tip.
- ☐ 7. Clean the tip of the soldering gun with a sponge.
- ☐ 8. Apply a small amount of solder to the tip.
- ☐ 9. Begin at one end of the splice and apply solder from the top as you move the tip of the soldering gun slowly along the underside of the splice.



- ☐ 10. Move the soldering tip slowly enough that the solder melts evenly onto the splice and runs down so that it fills all crevices where conductors meet.
- ☐ 11. Permit soldered splice to cool.
- ☐ 12. Have your instructor check your work.
- ☐ 13. Tape complete splice with plastic tape in a spiral wrap that slightly overlaps to assure a complete covering.



- ☐ 14. Repeat the procedure as required to make a simple splice on stranded wire.



- ☐ 15. Have your instructor check your work.

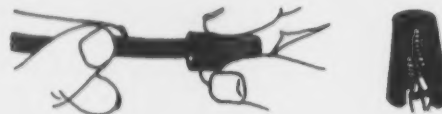
C. Routine 2—Making pigtail splices

- ☐ 1. Select two more pieces of single wire conductor.
- ☐ 2. Strip and bevel conductors as previously outlined.

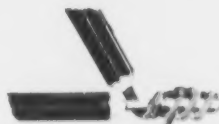
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Job Sheet 4

- ☐ 3. Place conductors side by side and start a twist on the end with your fingers or pliers, if required.
- ☐ 4. Place a screw-on cap of the proper size over the end of the two conductors and screw it clockwise down until it completely covers the bare conductors.



- ☐ 5. Have your instructor check your work.
- ☐ 6. Select two more pieces of single wire conductor and strip and bevel as previously outlined.
- ☐ 7. Prepare another pigtail splice, but this time, twist the wires out from the bevel around each other to form the pigtail.



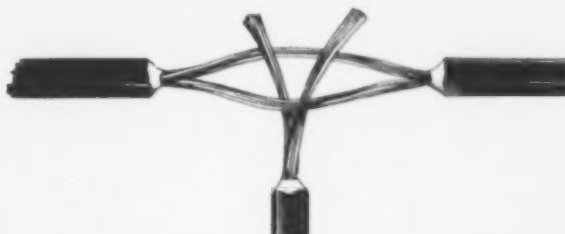
- ☐ 8. Heat the soldering tip again, clean it, tin it, and solder the pigtail with the same procedure used to solder the simple splice.
- ☐ 9. Permit the pigtail to cool.
- ☐ 10. Have your instructor check your work.
- ☐ 11. Tape the pigtail as previously outlined.
- ☐ 12. Repeat the procedure for splicing and soldering a single wire conductor and a stranded wire conductor into a pigtail.
- ☐ 13. Have your instructor check your work.
- ☐ 14. Tape the pigtail as previously outlined.

D. Routine 3—Making tap splices

- ☐ 1. Select two more pieces of single wire conductor.

Job Sheet 4

- ☐ 2. Strip about 1 ½" from the center of one conductor and bevel the insulation edges on both sides.
- ☐ 3. Strip one end of the other conductor and bevel as previously outlined.
- ☐ 4. Place the free end of the last conductor prepared at about the center of the first conductor and wrap the tap onto the bare space in the first conductor.



- ☐ 5. Heat the soldering tip again, clean it, tin it, and solder the tap with the same procedure previously used.
- ☐ 6. Permit the splice to cool.
- ☐ 7. Have your instructor check your work.
- ☐ 8. Tape the tap splice as previously outlined.
- ☐ 9. Repeat the procedures for splicing and soldering a stranded wire tap.



- ☐ 10. Permit the soldered splice to cool.
- ☐ 11. Have your instructor check your work.
- ☐ 12. Tape the tap splices as previously outlined.
- ☐ 13. Clean up area and return tools and equipment to proper storage.

Comments: _____

Tools, Materials, and Test Instruments
Unit 6

Job Sheet 5—Use a VOM for a Quick Capacitor Check

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Capacitor discharged as safety precaution	_____
VOM leads placed on capacitor terminals for reading	_____
VOM leads reversed on capacitor terminals for reading	_____
Capacitor evaluated as good, shorted, or open	_____

A. Tools and materials

Capacitor(s) as selected by instructor
VOM
Pencil and paper
Safety glasses

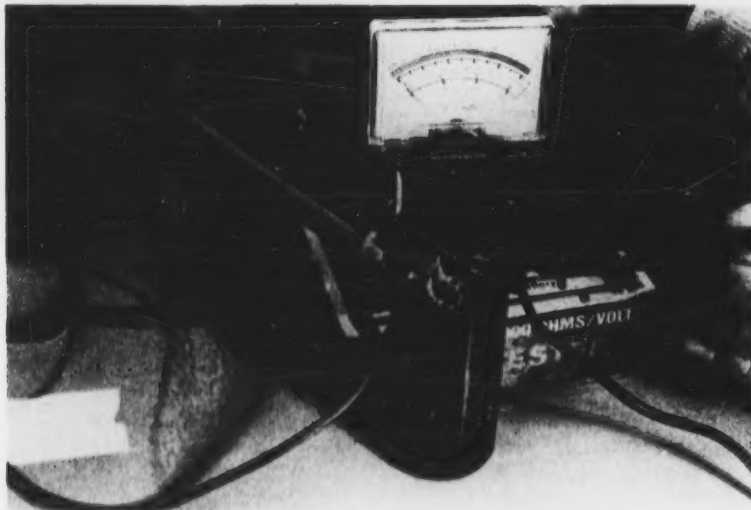
B. Procedure

- ☐ 1. Put on safety glasses and make sure the capacitor has been discharged if it has been recently energized.

Note: Check with your instructor for a safe discharging procedure.

Job Sheet 5

- ☐ 2. Connect VOM leads in any order to the capacitor terminals.



- ☐ 3. Check the indicator needle for movement about halfway across the scale and then a drop back to zero.
- ☐ 4. Reverse the VOM leads on the capacitor terminals.
- (a) If switching the meter leads back and forth continues to show a noticeable deflection and then a fall back to zero, the capacitor is okay.
 - (b) If there is more than a half-scale deflection and the needle will not return to zero, the capacitor is shorted.
 - (c) If there is no reading at all, the capacitor is open.
- ☐ 5. Record your findings for the first capacitor and repeat the procedure for other capacitors that your instructor may supply.
- ☐ 6. Record all findings.
- ☐ 7. Have your instructor check your work.
- ☐ 8. Clean up area and return tools and materials to proper storage.

Comments: _____

Automatic Washers

Unit 7

Objective Sheet



Unit Objective

After completing this unit, the student should be able to install an automatic washer, troubleshoot a Whirlpool/Kenmore automatic washer for typical malfunctions, and troubleshoot a GE/Hotpoint automatic washer for typical malfunctions. The student should demonstrate these competencies by completing the activities in the job sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to automatic washers with their correct definitions.
2. Match major components with their functions in an automatic washer.
3. Arrange in order the steps in a typical automatic washer cycle.
4. Complete statements about fill functions in a normal cycle.
5. Complete statements about agitation functions in a normal cycle.
6. Complete statements about pumpout and spin functions in a normal cycle.
7. Select true statements about guidelines for evaluating automatic washer malfunctions.
8. Arrange in order the steps in validating repairs.
9. Complete statements about troubleshooting a washer that will not fill with water.
10. Select true statements about troubleshooting a washer for improper water level or water temperature.
11. Select true statements about troubleshooting a washer when water will not shut off.
12. Complete statements about troubleshooting a washer that leaks water.
13. Complete statements about troubleshooting when water will not drain from the washer.

Objective Sheet

14. Select true statements about troubleshooting a washer with a motor that will not run.
15. Complete statements about troubleshooting a washer that will not agitate.
16. Complete statements about troubleshooting a washer that will not spin.
17. Select true statements about troubleshooting a washer that will not advance or shut off.
18. Select true statements about troubleshooting a washer that leaks oil.
19. Select true statements about troubleshooting a washer that tears clothes.
20. Match other washer problems with ways to correct them.
21. Install an automatic washer. (Job Sheet 1)
22. Troubleshoot a Whirlpool/Kenmore automatic washer for typical malfunctions. (Job Sheet 2)
23. Troubleshoot a GE/Hotpoint automatic washer for typical malfunctions. (Job Sheet 3)
24. Troubleshoot a microprocessor control panel for typical malfunctions. (Job Sheet 4)

**Automatic Washers
Unit 7**

Information Sheet

1. Terms and definitions

- a. **Automatic washer**—An appliance designed to clean dirty clothes in a wash, rinse, and spin-dry sequence controlled by a timer
- b. **Centrifugal**—The force that impels something outward from a rotating center
- c. **Cycle**—One complete performance of a series of events that completes a procedure
- d. **Electromechanical timer**—A timer that consists of a motorized dial and cam that makes electrical connections in a timed sequence following a manual start
- e. **Glazing**—The highly-polished look of hydrocarbon build-up resulting from heat produced by friction between brake shoes and their metal housings
- f. **Microprocessor-based timer**—A timer that uses a printed circuit board to make electronic connections in a timed sequence following user programming with a touchpad
- g. **Reciprocating**—Moving back and forth in an alternating motion

2. Major components and their functions in an automatic washer

- a. **Timer**—An electromechanical or microprocessor-based device started manually or programmed to control the sequence of operations of an automatic washer
- b. **Motor**—Drives or turns the transmission or power train to provide power for agitation and spin motion
- c. **Transmission**—Converts motor power into directional control of agitate and spin functions including reciprocating motion for agitation
- d. **Water pump**—Pumps water from the tub and may also recirculate the water in the tub by pulling it from the bottom of the tub and dumping it back in the top

Note: A single-stage pump only extracts water from a tub, but a two-stage pump extracts water and recirculates it.

- e. **Water pressure/level switch**—Controls water level in the tub when activated by water pressure or a float-type device

Information Sheet**3. Steps in a typical automatic washer cycle**

- a. First fill
- b. Wash agitation
- c. First pumpout and spin
- d. Second fill
- e. Rinse agitation
- f. Final pumpout and spin

4. Fill functions in a normal cycle

- a. Machine usually fills twice during one cycle.
- b. The first fill is a wash fill with hot, warm, or cold water selected manually or predetermined by timer setting.
- c. The second fill is a rinse fill with warm or cold water only (no hot water) determined by timer setting.
- d. Timer is usually set to automatically direct cold water to the tub during the rinse fill portion of the cycle.

5. Agitation functions in a normal cycle

- a. Machine usually agitates twice during one cycle.
- b. Agitation may be accomplished with reciprocating motion or by rotating a drum.
- c. The first agitation is a wash agitation which may vary from 6 to 18 minutes and is usually accomplished with a high-speed motor setting.
- d. The second agitation is a rinse agitation which may vary from 2 to 6 minutes and is usually accomplished with a high-speed motor setting.
- e. The wash agitation mixes detergent with water and creates action to dislodge and separate soil from clothes.
- f. The rinse agitation separates detergent residue and dislodges separated particles so that they will be removed with pumpout and not settle back onto the clothes.

6. Pumpout and spin functions in a normal cycle

- a. Machine usually pumps out and spins twice in one cycle.
- b. Pumpout is initiated by the timer and regulated by either the water level or water pressure switch.
- c. In most washers, the water pressure switch will not allow the timer to advance until the water has been pumped out to assure that the first spin will last 2 to 4 minutes.
- d. The spin action creates a centrifugal force which literally throws water from the clothes.
- e. The final spin usually lasts at least 4 minutes or longer and is always a high-speed motor function.
- f. On some machines, spray rinse is an added feature of the spin function so that any residue that collects on the clothes during the spin function will be rinsed off and pumped out.

7. Guidelines for evaluating automatic washer malfunctions

- a. Identify the washer brand and model number.

Note: Automatic washers from each manufacturer have problems that are peculiar to that brand, and recognizing the similarities or problems within a brand line can save troubleshooting time.
- b. Ask the customer to explain what the machine is not doing or what the machine is doing wrong.
- c. Take notes as required so you will remember what has been said if the customer should have to leave.
- d. Verify the problem with a physical inspection or run the washer in an attempt to duplicate the problem if running the washer is still practical.

8. Steps for validating repairs

- a. Run the washer through one full normal cycle.
- b. Do not manually advance the timer.

Information Sheet

- c. Make sure the washer:
 - (1) fills properly,
 - (2) agitates effectively,
 - (3) pumps out and spins properly, and
 - (4) shuts itself off.
- d. Double-check for leaks, and
- e. Check the machine for level.

9. Troubleshooting a washer that will not fill with water

- a. Check the obvious first:
 - (1) washer may not be properly turned on.
 - (2) hoses may be kinked.
 - (3) screens in the fill hoses may be clogged.
- b. Make sure a proper water supply is available to the machine.
- c. Check for proper voltage at the mixing valve with a VOM.

NOTE: An alternate check is to put the washer on a "fill" setting, turn the timer on, and feel the valve to see if it vibrates or listen for a humming noise; if the valve vibrates or makes a humming noise, this indicates proper voltage at the mixing valve, but be sure to exercise caution when working with live circuits.

- d. When a mixing valve is energized but still will not admit water, check for obstructions in the valve and remove them.
- e. Run a continuity check on the fill switch and replace as required.
- f. Check the temperature selection switch.
- g. Make sure it is not a timer problem.
- h. Check the lid switch to make sure it is making proper contact.

10. Troubleshooting a washer for improper water level or water temperature

- a. Check for reversed hot and cold water hoses.
- b. Check for the quality of the hot water supply.

Information Sheet

- c. Check for a faulty water level switch.
- d. Check for a faulty thermal element in the mixing valve if it is a thermal type mixing valve.
- e. Check for a faulty temperature selection switch in the control panel or timer.
- f. Check for faulty timer.
- g. If the washer has a spray rinse in the spin portion of the rinse cycle, and this doesn't work:
 - (1) Check for no cold water supply or a kinked cold water hose.
 - (2) Check for a clogged inlet screen.
 - (3) Check for a defective cold water solenoid in the mixing valve.
 - (4) Check for a defective timer.

Note: The contacts for the spray rinse action are usually separate from the other contacts in a timer, and although the spray rinse does not work, the washer may work well except for that feature.

11. Troubleshooting a washer when water will not shut off

- a. On time-fill washers, the failure of water to shut off may indicate a timer malfunction.

Note: A time-fill machine is one where water fill volume is controlled by setting the timer for the washer to fill for a given period of time.

- b. Check the water level/water pressure switch and replace it if it is defective.
- c. Check for foreign particles in the mixing valve, and if that is suspected, take the valve apart and remove them.

Note: Cleaning a mixing valve can be accomplished in the field, but if it does not correct the problem, the valve should be replaced.

- d. On pressure-filled models check for a break or pinhole in the air chamber or connecting tubing, and replace either or both as required.

Note: If water gets in the air chamber or pressure tube, it will have the same effect as a pinhole, and this sometimes happens when a washer is tilted for cleaning or for moving.

12. Troubleshooting a washer that leaks water

- a. Check for loose or cracked supply hoses and tighten or replace as required.
- b. Check for a loose drain hose and tighten or replace the clamp as required.
- c. Run the washer through a normal cycle and replace any hose that is broken or appears to be damaged.
- d. Check for worn or damaged supply hose washers.
- e. Check for leaky gaskets:
 - (1) around the water pump,
 - (2) where the transmission enters the outer tub,
 - (3) seals between the inner and outer tub, and
 - (4) outer tub gasket.
- f. Check for cracked housing at:
 - (1) outer tub, especially tubs made of plastic,
 - (2) water pump housing, and
 - (3) mixing valve housing.
- g. Replace any component with cracked housing.

13. Troubleshooting when water will not drain from a washer

- a. Check for a kinked or clogged drain hose and correct as required.
- b. Check for a water pump problem, and readjust the pump and tighten the pump drive.

Note: On models with a drain-before-spin feature, suds lock sometimes occurs, but this can usually be corrected by dumping cold water into the tub to break up the suds.

- c. Check for a loose belt at the water pump and adjust as required.
- d. Check for a faulty transfer or solenoid valve and replace as required.
- e. Check for a defective water pump and replace as required.
- f. Check for a faulty timer and replace as required.

Information Sheet

14. Troubleshooting a washer with a motor that will not run

- a. Make sure there is power to the machine.
- b. Check for a faulty door/lid switch and replace as required.
- c. Check for an overload device or other protective device in the circuit and replace as required.
- d. Check for a faulty timer and replace as required.
- e. Check for a faulty motor and replace as required.

15. Troubleshooting a washer that will not agitate

- a. Check for a motor malfunction and replace as required.
- b. Check timer for bad contacts and correct or replace as required.
- c. Check for a faulty transmission and repair or replace as required.
- d. Check for broken linkage or other agitation control mechanism.

Examples: The agitate drive roller on a Frigidaire, the agitate solenoid on the Kenmore, and the eccentric linkage connection of the Speed Queen are potential trouble spots.

- e. Check for a broken wire in circuitry and splice, tin, and insulate as required.
- f. Check for stripped splines in the agitator.

16. Troubleshooting a washer that will not spin

- a. If the washer will agitate but not spin, the motor is probably okay.
- b. Check timer for defective contacts and replace as required.
- c. Check the door or lid switch and replace as required.
- d. Check for a faulty transmission and repair or replace as required.
- e. Check for broken linkage or other spin control mechanisms.

Examples: The spin roller on a Frigidaire, the spin control solenoid on a Kenmore, and the fluid drive unit on a Speed Queen are spin control mechanisms.

- f. Check for a faulty water level switch and replace as required.
- g. Check for a broken wire in circuitry and splice, tin, and insulate as required.

17. Troubleshooting a washer that will not advance or shut off

- a. If the timer will not advance, check the timer contacts.
- b. Check for a defective timer and replace the timer if required or replace the timer motor if that is the problem.
- c. Replace a timer motor only with the exact type of motor removed or the timed cycles will all be wrong.
- d. Check for a break in the circuitry wiring and splice, tin, and insulate as required.

18. Troubleshooting a washer that leaks oil

- a. If oil leaks on the floor, check for a leak in the gearcase caused by a faulty gasket, damage to the gearcase housing, or a bad transmission seal.
- b. If oil leaks onto clothes in the tub, check for a faulty gearcase or transmission seal and replace seal or transmission as required.

Note: On Norge and GE washers, it is recommended that the transmission be replaced, but on Kenmore/Whirlpool washers, both the tub and transmission seals can be replaced.

19. Troubleshooting a washer that tears clothing

- a. Caution the user to use bleach wisely:
 - (1) do not use too much bleach.
 - (2) do not add bleach at the wrong time.
 - (3) add bleach to water before loading clothes in the tub, or dilute bleach with water before putting it in the tub.
- b. Check for a broken agitator and replace if required because chips and cracks in the agitator can tear clothes.
- c. Check for a defective inner tub or basket and replace as required.

20. Other washer problems and ways to correct them

- a. **Machine spins slowly**—Adjust belt to clutch or replace clutch if it is faulty
- b. **Water does not recirculate during agitation**—Clean out clogged water pump
- c. **Defective pump drive**—Tighten as needed or replace the coupling
- d. **Defective distribution valve**—Clean out or replace valve, or replace solenoid as required

Information Sheet

- e. **Timer will not advance to next cycle**—Replace timer motor, or replace entire timer as required
- f. **Frozen timer shaft or knob**—Check for obstructions and free the shaft or replace the timer as required
- g. **Faulty water level switch**—Replace the control
- h. **Washer vibrates excessively**—Reinforce weak floor or move washer, check for level, caution user not to overload or create unbalanced loads, or replace rubber cups on leveling feet
- i. **Tub vibrates excessively**—Check for a damaged snubber and replace as required, or adjust or replace suspension bolts

Note: Vibration may indicate a faulty transmission or worn bearings.

**Automatic Washers
Unit 7**

Job Sheet 1—Install an Automatic Washer

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Installation area inspected and acceptable	_____
Customer/installation literature saved for reference	_____
Electrical connections/grounding correctly completed	_____
Washer operated to verify correct installation	_____
Customer instructed about operation and maintenance	_____

A. Tools and materials

Washer as selected by instructor
Standard hand tools and tool box
VOM
Level
Dolly
Safety glasses

B. Procedure

- ☐ 1. Put on safety glasses.
- ☐ 2. Uncrate The washer carefully.
- ☐ 3. Visually inspect the washer to make sure it is not damaged.
- ☐ 4. Secure washer on a proper dolly if it must be moved any distance to the installation site.
- ☐ 5. Inspect the location where the washer will be installed for:
 - (a) level, sturdy floor,

Note: If the floor is not level and sturdy, point out to the customer that the condition could impair performance and eventually damage the washer; if the customer insists the floor remain as it is, have the customer sign a release.

Job Sheet 1

- (b) adequate supplies of hot and cold water,
 - (c) adequate drainage, and
 - (d) adequate clearance and ventilation.
- ☐ 6. Remove ties, blocks, tape, and any other retaining devices installed to protect the washer during shipment.
 - ☐ 7. Check inside the washer for the owner's manual, installation kit, or any other materials that should be removed and saved.
 - ☐ 8. Set the washer in place.
 - ☐ 9. Connect hot and cold water hoses.
 - ☐ 10. Install grounding kit.

Note: Grounding kit installation varies from washer to washer, but the instructions should be with the washer and they should be carefully followed.

- ☐ 11. Level the machine side to side and front to back.
- ☐ 12. Check the receptacle for proper voltage.
- ☐ 13. Plug the washer power cord into a three-hole grounded receptacle only.

Caution: Never use an adapter or an extension cord that defeats the ground connection on a washer power receptacle because it will void the warranty and damage the washer.

- ☐ 14. Operate the machine through one normal cycle.
- Note: Do not manually advance the timer; permit the washer to complete a full cycle on its own.
- ☐ 15. Explain operating procedure to the customer, and encourage the customer to follow recommended procedures for washer care and preventive maintenance.
 - ☐ 16. Check the installation order and make sure you have recorded all serial numbers and any other information required to assure a correct warranty.
 - ☐ 17. Clean up the installation area and make sure all crating materials or blocks and ties are removed from the customer's home.
 - ☐ 18. Remind the customer that your company should be called for any questions about the washer or its performance.
 - ☐ 19. Compliment the customer on making a wise decision in washer selection, and leave the customer on a positive note.

Job Sheet 1

- ☐ 20. Have your instructor check your work.
- ☐ 21. Return tools and materials to proper storage.

Comments: _____

**Automatic washers
Unit 7**

**Job Sheet 2—Troubleshoot a Whirlpool/Kenmore Automatic Washer
for Typical Malfunctions**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

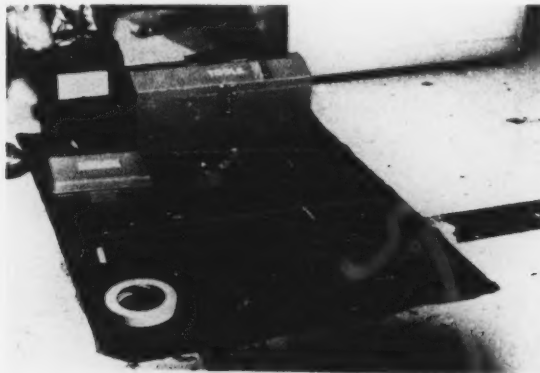
Evaluation Criteria	Rating
Control panel troubleshooting complete and correct	_____
Water level switch troubleshooting complete and correct	_____
Mixing valve troubleshooting complete and correct	_____
Water pump troubleshooting complete and correct	_____
Motor troubleshooting complete and correct	_____
Transmission tube troubleshooting complete and correct	_____
Clutch adjustment complete and correct	_____
Repair log complete with problems noted	_____

- A. Tools and materials
- Washer with service literature as selected by instructor
 - Standard hand tools and tool box
 - Motor test cord
 - Drop cord/inspection light
 - Drop cloth
 - VOM
 - Pressure bulb
 - Special Whirlpool/Kenmore tools
 - Spanner wrench #12393
 - Agitator drive block remover tool
 - Repair log (attached)
 - Safety glasses

Job Sheet 2

B. Routine 1—Troubleshoot the control panel

- ☐ 1. Sign on the repair log that accompanies this job sheet and save the log for use in later job sheets, and be sure to put on safety glasses.
- ☐ 2. Place drop cloth down, set the tool box on it, and generally prepare a safe uncluttered work area.



- ☐ 3. Unplug the washer.
- ☐ 4. Turn off water supply to hoses and disconnect fill hoses with channel-lock pliers.



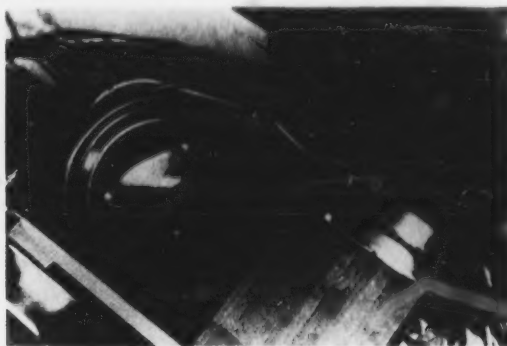
- ☐ 5. Remove the timer knob by holding the timer dial and turning the knob in a counter clockwise direction.

Job Sheet 2

- ☐ 6. Remove the timer dial by first removing any retaining screws or lock nuts and lift slightly to remove the timer dial.



- ☐ 7. Remove the screws that retain the control panel (console).
- ☐ 8. Move the control panel forward far enough to expose all electrical connections.
- ☐ 9. Unplug the electrical connection to the control panel (it plugs into the machine) and remove the fill hose from the water pressure switch.



- ☐ 10. Place a drop cloth on top of the washer and set the control panel out on top of the lid for each access.

Job Sheet 2

- ☐ 11. Disconnect the harness or individual leads to the timer and be sure to sketch or make notes of the location of each individual connector so you will know how to put them back.

Note: Failure to note the locations could cause you trouble later, and codes on schematics are not always reliable; even your knowledge of a particular appliance may not be counted on if you are dealing with a part some other technician has previously replaced.

- ☐ 12. Remove the inspection plate from the open-type timer and inspect the condition of the switch contacts.
- ☐ 13. Remove the timer motor and inspect the drive gear for frayed or worn spots that indicate wear.
- ☐ 14. Replace timer motor if wear is evident.
- ☐ 15. Test run the timer motor using a motor test cord:

- (a) scratch a mark at a point on the motor body and the gear to provide a reference point for checking timer motor rotation.

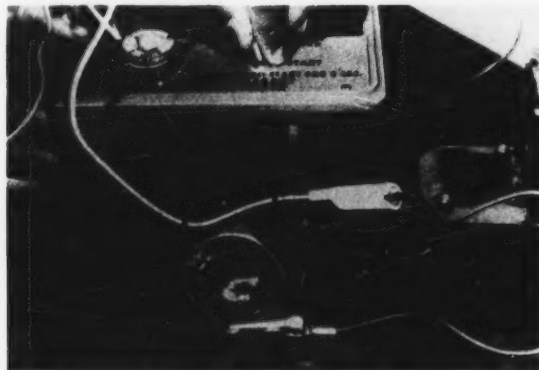
Caution: Be sure to make the mark clear because the motor advances so slowly that it cannot be seen by the naked eye.



- (b) connect motor test cord to timer motor (Robinaire Test Cord #12476). Use the black and white motor test leads.

Job Sheet 2

- (c) the test cord on to the RUN position and allow it to run for at least ten minutes.



- (d) if there is no noticeable timer motor advancement in a ten minute test period, the timer motor is defective and must be replaced.

- ☐ 16. Replace the old timer motor or install a new timer motor as test indicates.
- ☐ 17. Have your instructor check your timer removal.
- ☐ 18. Reinstall entire existing timer if it appears to be in good shape or replace the timer if it is obviously defective.

Note: Timer problems usually are obvious, but ask your instructor for help in your evaluation of the timer's condition.

- ☐ 19. Have your instructor check your timer installation.

Note: On a normal service call, the control panel would probably be reinstalled at this point, but leave it off for now.

- ☐ 20. Note on your repair log the length of time it took for you to accomplish Routine 1, and add five minutes to that figure to have a realistic assessment of the time it would have taken to remove, troubleshoot, and replace the timer.

C. Routine 2—Troubleshoot the water level switch

- ☐ 1. Sign on repair log and remove the knob from the water level switch.
- ☐ 2. Remove the retaining screw(s) that hold the switch.
- ☐ 3. Disconnect the individual leads to the water level switch and be sure to sketch the location of each individual lead so you can get each lead back in the proper location.

Job Sheet 2

- ☐ 4. Inspect the switch visually for any physical damage such as breaks or cracks in the housing or loose or corroded terminals.
- ☐ 5. Perform a continuity test on the water level switch contacts with the following procedure:

- (a) sketch two pictorial diagrams of the three water level switch terminals and label the terminals V, P, or T to indicate they are violet, pink, or tan.

Example: 1. V P T

 2. V P T

- (b) make the continuity test across the three switch terminals from V to T, from V to P, and from T to P.
 - (c) when the reading between any two terminals is zero ohms, connect those two terminals with a straight line (V____T) (V____P).
 - (d) when the reading between any two terminals is infinite ohms, which generally indicates an open circuit, leave the space between the terminals blank (T P).
- ☐ 6. Evaluate your first continuity test according to the following:
 - (a) if there is no line between the tan and violet terminals and there is a line between the violet and pink terminals, it indicates the switch is in the empty position and is probably okay.
 - (b) If the lines and open space are reversed, it indicates the switch is stuck in the full position and should be replaced.
 - ☐ 7. Perform another continuity test on the water level switch with the following procedure:
 - (a) attach a pressure bulb to the water level switch at the opening to the diaphragm



Job Sheet 2

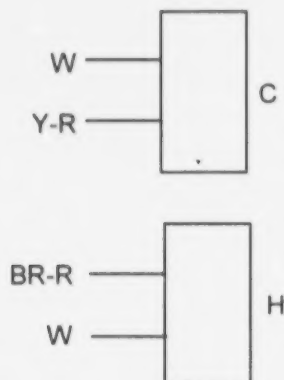
- (b) apply pressure to the bulb, listen for a clicking sound which indicates the diaphragm has moved to shift switch contacts, and at the same time take a continuity reading between terminals V and T.
 - (c) with no pressure, continuity between V and T should be infinite.
 - (d) when pressure is applied, continuity between V and T should be zero ohms.
 - (e) use your second diagram to indicate your final continuity reading.
 - (f) if there is an infinite reading between V and T with no pressure and a zero ohms reading between V and T when pressure is applied, the switch is shifting from the empty to the full position properly and should be a good switch.
- ☐ 8. Evaluate your continuity test and replace water level switch if required or put the old switch back in place.
 - ☐ 9. Replace the entire control panel.
 - ☐ 10. Note on your repair log the length of time it took to accomplish Routine 2.
 - ☐ 11. Have your instructor check your work.
 - ☐ 12. Clean up area and return tools and materials to proper storage or proceed to next routine as directed by your instructor.
- D. Routine 3—Troubleshoot the mixing valve
- ☐ 1. Sign on your repair log.
 - ☐ 2. Raise the lid and secure it, and then locate the mixing valve.

Note: Refer to manufacturer's technical manual or ask your instructor if you have any questions about this procedure.

Job Sheet 2

- ☐ 3. Make a pictorial sketch of all conductors that lead to the mixing valve solenoids and note their identifying markings.

Note This is to avoid the prospects that the cold water conductors will not be hooked up to the hot water solenoid, or vice versa, when the mixing valve is reinstalled.



- ☐ 4. Remove the mixing valve.
- ☐ 5. Remove the solenoids from the mixing valve and make a continuity check with the following procedure:

- (a) check the cold water solenoid for continuity across the terminals and record the reading.
- (b) check the hot water solenoid for continuity across the terminals and record the reading.
- (c) if it is a three-solenoid valve, check the warm water solenoid for continuity across the terminals and record the reading.

Note: The continuity reading should indicate a resistance reading of around 500-2000 ohms on the ohmmeter scale.

- ☐ 6. Conduct an electrical test on the solenoids with the following procedure:
- (a) you will need the Robinaire 1246 motor test cord and a paper clip.
 - (b) connect the motor test cord to the cold water solenoid (use the black and white leads on the test cord).
 - (c) turn the test cord to RUN and listen for a humming sound in the solenoid.

Job Sheet 2

- (d) place the paper clip near the solenoid opening and note whether or not the solenoid pulls the paper clip inside the solenoid.

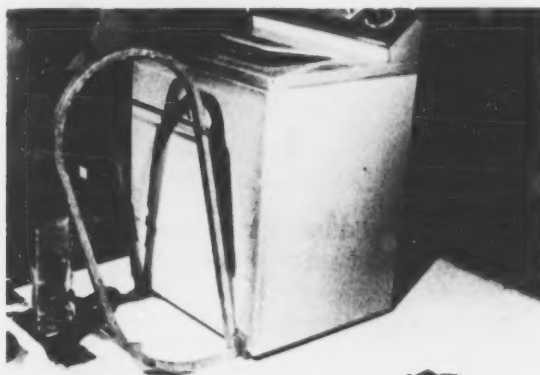


- (e) if the solenoid attracts the paper clip, it is probably good, and if there is no magnetic attraction present, the solenoid is probably defective.
- ☐ 7. Repeat the electrical test for the hot water solenoid and for the warm water solenoid, if there is one.
 - ☐ 8. Have your instructor check your work.
 - ☐ 9. Dismantle the mixing valve.
 - ☐ 10. Inspect the mixing valve diaphragm and other mixing valve parts and look for foreign particles and wear.
 - (a) if foreign particles are present, remove them.
 - (b) if valve parts evidence extensive wear, replace the mixing valve.
 - ☐ 11. Replace the mixing valve if the valve itself is worn or if any of the solenoids are defective because it is more cost-effective to replace than to repair.
 - ☐ 12. Put the valve back together and reinstall it or install a new mixing valve.
 - ☐ 13. Have your instructor check your work.
 - ☐ 14. Note on your repair log the length of time it took for you to accomplish Routine 3.

Job Sheet 2

E. Routine 4—Troubleshoot the water pump

- ☐ 1. Sign on your repair log.
- ☐ 2. Assemble special tools required for the routine:
- ☐ 3. Insert the flipper under the front of the machine and turn the machine over on its front so that the underside of the washer is readily accessible.



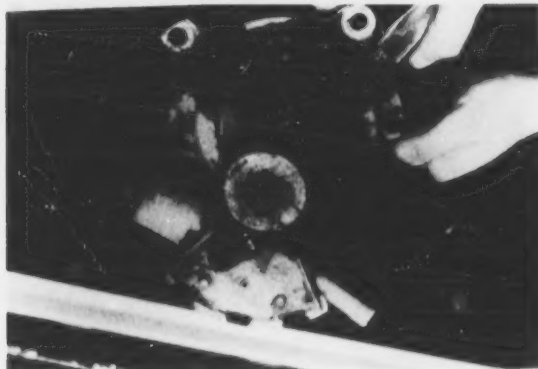
- ☐ 4. Place drop cloth down and arrange tool box to one side.
- ☐ 5. Use hose-clamp pliers to remove the hoses from the water pump and note their locations so you will get them back in the right place.
- ☐ 6. Loosen motor mounting bolts enough to provide enough slack in the drive belt that the belt can be removed.
- ☐ 7. Remove the two water pump retaining bolts.
- ☐ 8. Slip the pump away from the bolt and out of the washer.
- ☐ 9. Clean the pump as required and then inspect it for obstructions, and make sure it turns freely.

Job Sheet 2

- ☐ 10. Dismantle the pump and clean the impeller if it is a two-piece pump connected with retaining clips or screws.



- ☐ 11. Put pump back together.
- ☐ 12. Shift the directional level on the pump to make sure the direction control baffle inside the pump moves back and forth.



- ☐ 13. Reinstall the old pump if it is okay, or install a replacement pump if required.
- ☐ 14. Have your instructor check your work.
- ☐ 15. Note on your repair log the length of time it took for you to accomplish Routine 4.

Job Sheet 2

F. Routine 5—Troubleshoot the motor

- ☐ 1. Sign on your repair log.
- ☐ 2. Disconnect all electrical conductors to the motor and note where they go and their identifying colors and markings:
 - (a) single-speed motors should have two conductors, one blue and one white,
 - (b) two-speed motors should have three conductors, one blue, one orange, and one white.
 - (c) three-speed motors should have four conductors, one blue, one orange, one gray/pink, and one white.
- ☐ 3. Remove the two motor retaining bolts.
- ☐ 4. Remove the motor and place it on the drop cloth.
- ☐ 5. Conduct a continuity test on the motor with the following procedure:
 - (a) sketch two pictorial diagrams of the motor switch terminals and their identifying markings.



- (b) make a continuity check on the motor control terminals.
- (c) write meter readings on the first diagram, and this will probably be a reading of less than two ohms.

Note: If the motor is equipped with a capacitor, discharge the capacitor with a 2,000 ohm 2-watt resistor and short capacitor leads together.

- (d) record the resistance across the terminals.

Job Sheet 2

- (e) using a pencil or some other wooden object, depress the centrifugal mechanism.
- (f) record the resistance across the terminal with the centrifugal mechanism depressed.



- 6. Evaluate your continuity check according to the following:
 - (a) on a single speed (two terminal) motor, two things should happen:
 - 1) the first resistance reading should be a relatively low reading, approximately 2 ohms or less.
 - 2) the second reading with the centrifugal mechanism depressed should increase slightly to about 2 ohms.
 - (b) If the first reading was a resistance of 2 ohms or more, the starting switch is defective, and depending on the application, replace the switch or the entire motor.

Note: On the throw-away motor, the starting switch can be replaced, and on the conventional motor it is not cost-effective to attempt internal motor repair.
 - (c) if a resistance reading of zero ohms, infinite continuity, or a high resistance greater than 3 ohms comes up in your continuity check, either the starting switch or the motor itself is defective and should be repaired or replaced as previously indicated.

Note: For directions on continuity checks for two and three-speed motors, check the manufacturer's service material.
- 7. Conduct continuity check and evaluations for two-speed and three-speed motors with the same general procedure outlined for single-speed motors.

Job Sheet 2

- ☐ 8. Test run the motor using a test cord with the following procedure:

- (a) connect the test cord to the motor.

Note: This procedure is for a single-speed motor only; check service manual for two- or three-speed motor procedures.

- (b) use the black and white leads from the test cord and connect the black lead to the blue motor terminal and the white lead to the white motor terminal.
- (c) turn motor test switch to RUN.



- (d) if the motor starts and runs, it is okay.
- (e) if the motor does not start, or starts and runs erratically, the motor is defective and should be replaced.

Note: A current or amperage check should be made on the motor, but it can only be made with the motor under a real or simulated load.

- ☐ 9. Reinstall the motor and adjust the drive belt, but do not reconnect motor conductors yet.
- ☐ 10. Turn the appliance flipper so that the washer is upright again.
- ☐ 11. Connect the motor test cord to the motor as previously outlined.
- ☐ 12. Connect a clamparound ammeter to the white motor test lead.
- ☐ 13. Set the ammeter on high scale and turn test cord to RUN.

Job Sheet 2

- ☐ 14. Check amperage reading and compare your reading with the amperage specified on the motor identification plate.

Note: The amount of current actually drawn by the motor under load should never be equal to or more than the full load amperage listed on the motor identification plate because the FLA reflects maximum capability and a washer motor should never function to its maximum potential.

- ☐ 15. Have your instructor check your amperage reading.
- ☐ 16. Replace the motor if amperage check indicates it is bad, but otherwise, make conductor connections and replace the old motor if all checks indicate it is probably okay.
- ☐ 17. Note on your repair log the length of time it took for you to accomplish Routine 5.

G. Routine 6—Troubleshoot the transmission/spin tube assembly

- ☐ 1. Sign on your repair log.
- ☐ 2. Raise the top according to directions in the service manual.

Note: On some models this may mean removing the recirculating hose first, but other models simply raise up; in all cases, it is a good idea to tape the lid down before moving the top.



Job Sheet 2

- ☐ 3. Remove the snubber by lifting up on the snubber retaining spring and lifting the snubber out of its spring support.



- ☐ 4. Remove the snubber retaining spring by removing the retaining nut and pulling the spring toward the front of the washer while pushing down on the back of the spring.
- ☐ 5. Remove the water inlet from the tub ring.

Note: On some models the inlet snaps in and out, and on other models it is held by a retaining screw that has to be removed.



- ☐ 6. Remove the tub ring and gasket with the following procedure.
- (a) remove the clips or fasteners that hold the tub ring and be sure to note colors and sizes of clips by location.
 - (b) lift up on the tub ring to remove it.

- (c) remove the tub ring gasket.



- ☐ 7. Remove the agitator.

Note: Check the service manual for the procedure because agitator removal varies significantly from model to model.

- ☐ 8. Remove the agitator drive block (if there is one) with the following procedure:

- (a) insert the forks of a tie rod separator tool between the agitator drive block and the spin drive block.
- (b) drive the tool forward with a ball peen hammer and pry upward to remove the agitator drive block.

Note: If there is a stud that still retains the agitator drive block, it has to be removed before the block can be removed.

- ☐ 9. Remove the spanner lock nut with the following procedure:

- (a) place the spanner wrench over the nut so that it catches the grooves in the nut.

Job Sheet 2

- (b) tap the spanner wrench with a ball peen hammer in a counterclockwise direction to loosen it.



- (c) remove the spanner nut.

- ☐ 10. Remove the inner tub by lifting it up and out.



- ☐ 11. Remove the basket drive block.

Note: The basket drive block may have come out with the basket, and if so, just take the wooden end of your hammer and push the drive block out.



Job Sheet 2

- ☐ 12. Insert the flipper under the front of the machine and flip it over once again.
- ☐ 13. Remove all hoses from the water pump and get them out of the way.
- ☐ 14. Remove the water pump as previously outlined.
- ☐ 15. Remove all retaining or support braces (there may be as many as three) from the transmission and spin tube assembly/basket drive assembly.



- ☐ 16. Disconnect all electrical conductors from the spin/agitate solenoids mounted on the transmission and be sure to note the identifying colors and locations.
- ☐ 17. Remove the three transmission mounting bolts.

Note: The transmission bolt mounted on the underside has a spacer between the transmission and the frame, so be sure to keep track of the spacer for proper reinstallation.



- ☐ 18. Remove the belt from motor drive pulley.

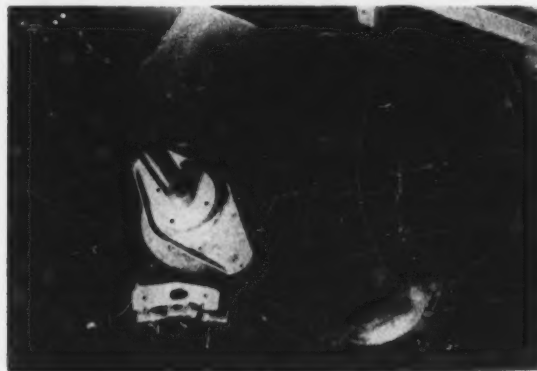
Job Sheet 2

- 19. Remove transmission and spin tube assembly by pulling on the spin tube assembly, not the transmission, so that the two will come out together.

Note: Pulling on the spin tube helps prevent damage to the retainer and spring at the top of the spin tube assembly, but do not lift the transmission from the agitator shaft because it will dislodge the thrust washer under the shaft.



- 20. Remove spin tube assembly from transmission with the following procedure:
- (a) remove the spring and retaining clip that hold the top of the spin tube assembly.
 - (b) lift the spin tube assembly up and off and inspect it.



- (c) look for worn areas on the brake and on the clutch pad, and also broken or missing springs.
- (d) check your service manual to see what components in the spin tube assembly can be replaced in the field.

Note: Generally, if any components in the spin tube assembly are damaged, it is more cost-effective to replace the entire spin tube assembly.

Job Sheet 2

- ☐ 21. Remove the thrust bearing (called a T-bearing) by slipping it off the agitator shaft.

Caution: Some models have ball bearings, and they are easy to lose if you are not careful.

- ☐ 22. Inspect the T-bearing for frayed or broken edges, and if it is a plastic bearing, it may have swelled from excessive wear.
- ☐ 23. Replace the T-bearing as required.
- ☐ 24. Check the agitate/spin solenoids with the following procedure:
- (a) remove the solenoid mounting screw, and lift the solenoid out.



- (b) conduct a continuity test on the agitate solenoid and record the resistance reading.
- (c) conduct a continuity test on the spin solenoid and record the resistance reading.

Note: Refer to the procedure outlined for checking the mixer valve solenoids if you have questions about this procedure.

- (d) the resistance reading should be 200-700 ohms in each solenoid to indicate that the solenoid is working okay.
- ☐ 25. Conduct an electrical test on the agitate/spin solenoids with the same procedure outlined for the electrical tests for the mixer valve outlined in Routine 3.
- ☐ 26. Replace the agitate/spin solenoids if they are defective, or reinstall them if they appear to be okay.

Job Sheet 2

- ☐ 27. Inspect the transmission with the following procedure:
- (a) check the spin cam bar to make sure it is not warped or that it has damaged edges.
 - (b) check the agitator cam bar to make sure it is not warped or that it has damaged edges.
 - (c) check the agitate and spin drive plungers to make sure the hardened pin is in good shape and that the plunger itself has no rough edges.

Note: Work the plungers up and down so you can make a good evaluation.
 - (d) check the operation of the transmission by manually shifting it from agitate to spin and rotating the drive pulley.
 - (e) If no damage or wear is noted, reassemble the transmission.

Note: Should there be evidence that the transmission required internal repair, check your service manual for procedure, and continue with transmission repair or replace the transmission as directed by your instructor.
- ☐ 28. Replace the transmission and spin tube assembly by reversing the disassembly procedure.

Note: Be sure to replace solenoid wiring through the hole in the control magnet assembly.
- ☐ 29. Have your instructor check your work.
- ☐ 30. Reinstall all hoses.
- ☐ 31. Make all necessary electrical and water connections.
- ☐ 32. Level the machine.
- ☐ 33. Plug washer in and run it through a normal cycle to check it:
- (a) if the washer will not pull a fairly heavy load, go on to Routine 7 and adjust the clutch.
 - (b) if you can keep the agitator from moving back and forth by holding it with your hand, that means the clutch needs adjustment and you should go on to Routine 7.
- ☐ 34. Note on your repair log the length of time it took you to complete Routine 6.

Job Sheet 2

- ☐ 35. Have your instructor check your work.

H. Routine 7—Adjust the clutch

- ☐ 1. Sign on your repair log.
- ☐ 2. Make tests as outlined in Routine 6 to confirm that the clutch needs adjusting.
- ☐ 3. Position yourself so you can reach the adjustment nut at the top of the basket clutch shaft.



- ☐ 4. Put a $\frac{3}{4}$ " open-end wrench on the nut and move the adjustment nut according to the following:
- (a) if the agitator has no torque, run the adjustment nut down about $\frac{1}{8}$ th of a turn.
- (b) if the agitator has too much torque, run the adjustment nut up about $\frac{1}{8}$ th of a turn.
- ☐ 5. Place the machine level and run a test load to check for proper torque and good agitation.
- ☐ 6. Drain the washer, unplug it from its power source, and make further adjustments as required.
- ☐ 7. Have your instructor check your work.
- ☐ 8. Sign off your repair log and be sure to note any special problems you have had with any of the routines in this job sheet.
- ☐ 9. Clean up area and return tools and equipment to proper storage.

Comments: _____

**Automatic Washers
Unit 7****Job Sheet 2****Repair Log**

Your name _____ Date _____

	Date	Time On	Time Off
Routine 1—Troubleshoot the control panel			
Routine 2—Troubleshoot the water level switch			
Routine 3—Troubleshoot the mixing valve			
Routine 4—Troubleshoot the water pump			
Routine 5—Troubleshoot the motor			
Routine 6—Troubleshoot the transmission/spin tube assembly			
Routine 7—Adjust the clutch			

Note any special problems you encountered in any of your troubleshooting routines:

Automatic Washers
Unit 7

**Job Sheet 3—Troubleshoot a GE/Hotpoint Automatic Washer
for Typical Malfunctions**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Correct troubleshooting for washer that will not pump out	_____
Correct troubleshooting for timer problems	_____
Correct troubleshooting for water pressure switch problems	_____
Correct troubleshooting for water fill valves	_____
Correct troubleshooting for water pump problems	_____
Repair log complete with problems noted	_____

A. Tools and materials

Washer with service literature as selected by instructor
 Standard hand tools and tool box
 Motor test cord
 Drop cord/inspection light
 Drop cloth
 VOM
 Pressure bulb
 Special Whirlpool/Kenmore tools
 Spanner wrench #12393
 Agitator drive block remover tool
 Repair log (attached)
 Safety glasses

B. Routine 1—Troubleshoot a washer that will not pump out

- ☐ 1. Sign on your repair log and put on safety glasses.
- ☐ 2. Verify the complaint by attempting to run the washer through a normal cycle:
 - (a) if the washer goes through a complete cycle but will not pull a load, or if agitate action is sluggish, the timer is probably okay and the trouble is probably in the brake and clutch assembly.

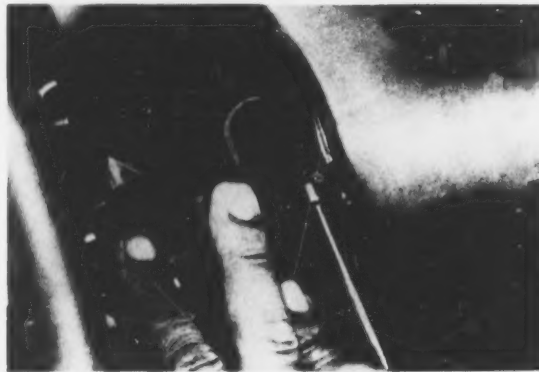
Job Sheet 3

- (b) if the timer will not advance, or if other functions will not work automatically, the timer or parts of the timer are bad and will have to be repaired.

Note: A distinctive feature of the GE/Hotpoint washer is that the timer does not have to be replaced as a unit; it can be repaired.

- (c) if the complaint indicates problems with the clutch and brake assembly, continue with Routine 1, and if it is a timer problem, go on to Routine 2.

- ☐ 3. Drain the washer and unplug it from its power source.
- ☐ 4. Strap the washer to an appliance flipper and turn it over on its face or turn the washer over onto a blanket or comforter.
- ☐ 5. Disconnect the web coupling between the pump and the clutch drive assembly, and be sure to save the clamp.



- ☐ 6. Mark the leads to the motor terminals so you will know how to put them back, and then remove the leads to the motor.

Note: Some units will have a plug that is easy to unsnap.

- ☐ 7. Remove the motor and clutch/brake assembly as a unit, and place it on a workbench.

Job Sheet 3

- ☐ 8. Use a ball peen hammer and a punch to remove the dowel pin at the bottom of the web coupling.



- ☐ 9. Put nails or pieces of wire through the small holes of the slip shoes where the shoes extend through the outer drum assembly.



- ☐ 10. Remove the outer drum assembly.
- ☐ 11. Inspect the primary shoes and the inner lock-in and outer lock-in shoes for glazing or excessive wear, and continue with disassembly as required to remove worn brake shoes.

Job Sheet 3

- ☐ 12. Remove the U-bolt and plate clamp from the shaft extension assembly.



- ☐ 13. Remove the washer, clutch leaf spring, and the primary shoe assembly and be sure to keep everything in order so you can reassemble everything properly.
- ☐ 14. Remove the shaft extension assembly from the motor shaft; this may require using some spray lubricant and working the assembly back and forth, or even using a small pry bar.



Job Sheet 3

- ☐ 15. Remove the outer and inner lock-in shoes, and be sure to keep all washers and springs in order.



- ☐ 16. Replace the outer and inner lock-in shoes as required, and be sure to get all springs and washers in their proper places.
- ☐ 17. Replace the shaft extension assembly and secure the U-bolt and plate clamp in place on the motor shaft.
- ☐ 18. Replace the primary shoes as required, and be sure to get all washers and springs back in their correct places.
- ☐ 19. Inspect the inner surfaces of the slip shoes for excessive wear and glazing, and replace as required.
- ☐ 20. Replace the clutch leaf spring and washer over the primary shoe assembly.
- ☐ 21. Replace the outer drum assembly.
- ☐ 22. Replace the retaining rings and bearings in proper order.
- ☐ 23. Replace the lower drive plate and drive the dowel pin back into place with a punch and a ball peen hammer.
- ☐ 24. Have your instructor check your work.
- ☐ 25. Fit the motor and clutch/brake assembly back into place, and secure the motor loosely to its mountings.
- ☐ 26. Attach the drive belt by moving the motor out until the belt has a deflection equal to the width of the belt when a moderate amount of pressure is applied, and then tighten the motor in place.

Job Sheet 3

- ☐ 27. Reattach the web coupling to the lower drive with the clamp that was previously removed.
- ☐ 28. Place washer upright and check all hoses.
- ☐ 29. Plug washer into properly grounded power supply.
- ☐ 30. Run the washer through a complete cycle and check for proper operation.
- ☐ 31. Have your instructor check your work and sign off repair log.

C. Routine 2—Troubleshooting the timer

- ☐ 1. Sign on your repair log.
- ☐ 2. Unplug the washer from its power source.
- ☐ 3. Remove the screws on each end of the console and turn the console over onto the lid so you can conveniently get to the timer and to the service information stored inside the console.



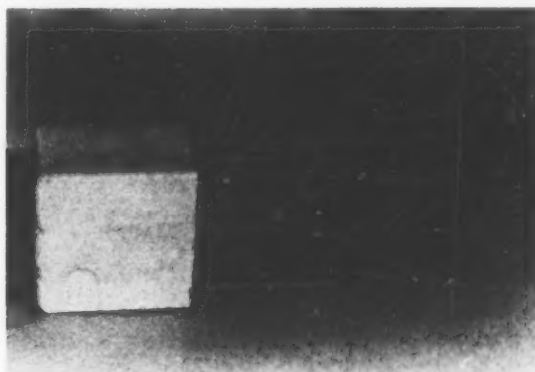
- ☐ 4. Start your troubleshooting based on the complaint that the washer will not fill, and since this involves checking the timer cams that control the fill functions, you will have to remove the timer:
 - (a) if there is a timer schematic attached to the back of the console panel, look it over to make sure you understand how to replace all leads or plugs before you remove them.

Job Sheet 3

- (b) if there is no schematic attached, sketch the wiring harness, and label the color codes for every terminal.



- ☐ 5. Remove the four Phillips screws that hold the top half of the timer in place, but hold the timer in place with your other hand as you take the screws out.
- ☐ 6. Remove the top half of the timer, making sure that any springs or small gears that are part of the assembly.
- ☐ 7. Make sure the metal inserts in the cam follower stay in place, and if the dowel-like inserts should come out of the cam follower, check the service information for proper replacement.
- ☐ 8. Take the top half of the timer to a workbench, turn it over carefully, and set it down in a clean work space.
- ☐ 9. Inspect all contacts on the timer switches for evidence of discoloration which indicates burned contacts, or for spots where contacts obviously burned.



Job Sheet 3

- ☐ 10. Replace switch assemblies as required according to the following:
 - (a) the switch assembly with 2 terminals is part #WH12X94.
 - (b) the switch assembly with 3 terminals is part #WH12X195, or it may be the 3 terminal switch used with the long silver plunger, and that is part #WH12X395.
 - (c) the switch assembly with 4 terminals is part #WH12X410.
 - (d) the switch assembly with 5 terminals is part #WH12X97.

Note: If you have any doubts about which switch to use, check the service information and the inserts in the cam follower.

- ☐ 11. Use a 1/4" nut driver to remove the old switches and to tighten the new switches in place, but do not overtighten the studs or you will break the plastic housing.
- ☐ 12. Double-check the inserts in the cam follower to make sure they are in the proper places, and then reassemble the timer.
- ☐ 13. Replace the timer in the console, and put the four Phillips screws back in place.
- ☐ 14. Put all the leads back in place on the proper timer switch terminals.
- ☐ 15. Have your instructor check your work.
- ☐ 16. Put the console back in place and secure it.
- ☐ 17. Plug the washer into a properly grounded receptacle and run it through a complete cycle:
 - (a) if the washer goes through the cycle properly, the new switch or switches have corrected the problem.
 - (b) if the washer does not fill properly, go on to the next routine for checking the water pressure switch.
- ☐ 18. Have your instructor check your work and sign off repair log.

Job Sheet 3

D. Routine 3—Check the water pressure switch

- ☐ 1. Sign on your repair log.
- ☐ 2. Unplug the washer from its power source.
- ☐ 3. Remove the screws that hold the console in place, and turn the console over onto the washer lid.
- ☐ 4. Disconnect the three leads to the pressure switch.



- ☐ 5. Set your VOM to measure ohms on the R x 1 scale.
- ☐ 6. Remove the air hose from the pressure switch and visually inspect it to make sure it is not damaged.
- ☐ 7. Find another piece of hose the same size as the pressure switch hose and install it onto the pressure switch with one end clear so you can blow through it.
- ☐ 8. Set your VOM to measure ohms on the R x 1 scale.
- ☐ 9. Place one VOM lead on the violet terminal and the other VOM lead on the purple or red terminal.
- ☐ 10. Verify that there is a full scale deflection on the VOM, which will indicate little or no resistance.
- ☐ 11. Leave the first lead on the violet terminal, remove the second lead from the purple or red terminal, and place it on the tan terminal.

Job Sheet 3

- ☐ 12. Verify that there is no reading on the VOM.
- ☐ 13. Blow into the tube, listen for a clicking sound, and verify a full scale deflection on the VOM to verify that the pressure switch is okay.



- ☐ 14. Have your instructor check your work.
- ☐ 15. Inspect all wires and terminals associated with the pressure switch, and repair or replace as needed.
- ☐ 16. Have your instructor check your work.
- ☐ 17. Replace the leads to the pressure switch, the pressure switch hose, and then replace the console.
- ☐ 18. Plug the washer into a grounded receptacle and run it through a complete cycle:
 - (a) if the washer fills properly, you have solved the problem.
 - (b) if the washer still has fill problems, go on to the next routine.
- ☐ 19. Have your instructor check your work and sign off your repair log.

E. Routine 4—Check the water fill valves

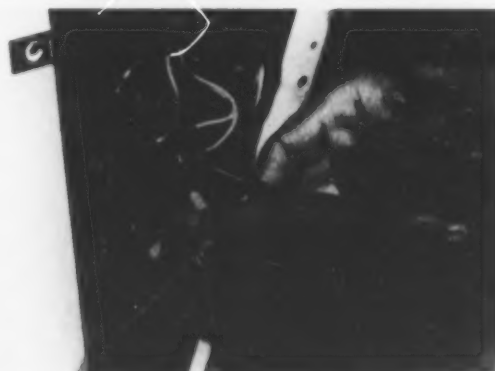
- ☐ 1. Sign on your repair log.
- ☐ 2. Unplug the washer from its power source.
- ☐ 3. Turn off the hot and cold water supplies and remove the hoses from the washer.

Job Sheet 3

- ☐ 4. Remove the mounting screws that hold the water valve mounting bracket on the back of the washer.



- ☐ 5. Pull the water valve solenoids out so you can conveniently check them.
- ☐ 6. Make a sketch of the leads to the solenoids so you will get them back in the proper places, and then remove the leads.
- ☐ 7. Set your VOM to measure ohms on the R x 100 scale.
- ☐ 8. Place the VOM leads on the two terminals of one of the solenoids.



- ☐ 9. Look for a reading of approximately 525 ohms:
 - (a) if the reading is too high, it means the solenoid should be replaced.
 - (b) if there is no reading, it means the solenoid has an opening and should be replaced.
- ☐ 10. Repeat the procedure for the other solenoid.

Job Sheet 3

- ☐ 11. Replace solenoids as required.
- ☐ 12. Have your instructor check your work.
- ☐ 13. Secure the solenoid support bracket.
- ☐ 14. Replace the hot and cold water hoses.
- ☐ 15. Turn on the hot and cold water supplies.
- ☐ 16. Plug the washer into a grounded receptacle and run it through a complete cycle.
- ☐ 17. Have your instructor check your work and sign off repair log.

F. Routine 5—Check the water pump

- ☐ 1. Sign on your repair log.

Note: Failure to pump out water is a common washer complaint, and it almost always means trouble with the water pump.

- ☐ 2. Unplug the washer from its power source and turn off and disconnect the hot and cold water supplies.
- ☐ 3. Secure the washer to an appliance flipper and turn it over on its front side.
- ☐ 4. Use snap-ring pliers to remove the clamps from the hoses on the pump, and then remove the hoses.
- ☐ 5. Inspect the two pump openings to make sure there are no small or delicate pieces of clothing clogging the openings.

Note: Since GE/Hotpoint washers have no holes in the tub except at the top of the rim, the washers have to spin water out over the top of the tub, and small or delicate articles of clothing sometimes get past the clothes guard and are drawn into the water pump.

Job Sheet 3

MAR-261

- ☐ 6. Remove the top half of the web coupling to free the water pump.
- ☐ 7. Remove the three screws holding the pump to the tub bracket.



- ☐ 8. Remove the pump, take it to a workbench, and remove the six screws that hold the pump together.
- ☐ 9. Scrape off detergent build-up inside the pump, and be careful not to damage the gasket.



Job Sheet 3

- ☐ 10. Inspect the impeller and pump valve for worn or broken vanes.
- ☐ 11. Replace broken or worn pump parts as they are available.

Note: Pump kits are available, but broken or worn parts usually mean the entire pump assembly has to be replaced.

- ☐ 12. Reassemble the pump.
- ☐ 13. Remount the pump on the tub bracket and replace the pump hoses.
- ☐ 14. Reconnect the web coupling.
- ☐ 15. Have your instructor check your work.
- ☐ 16. Set the washer upright, reconnect the hot and cold water hoses, and plug the washer into a grounded receptacle.
- ☐ 17. Run the washer through a complete cycle to verify that the pump is working properly.
- ☐ 18. Have your instructor check your work.
- ☐ 19. Sign off your repair and be sure to note any special problems you had with any of the routines in this job sheet.
- ☐ 20. Clean up area and return tools and materials to proper storage.

Comments: _____

**Automatic Washers
Unit 7****Job Sheet 3****Repair Log**

Your name _____ Date _____

	Date	Time On	Time Off
Routine 1—Troubleshoot a washer that will not pump out			
Routine 2—Troubleshoot the timer			
Routine 3—Troubleshoot the water pressure switch			
Routine 4—Troubleshoot the water fill valves			
Routine 5—Troubleshoot the water pump			

Note any special problems you encountered in any of your troubleshooting routines:

**Automatic Washers
Unit 7**

**Job Sheet 4—Troubleshoot a Microprocessor Control Panel
for Typical Malfunctions**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Self-diagnostic tests completed per service manual	_____
Control panel removed and replaced, if required	_____
Touchpad checked for proper resistance readings	_____
Primary and secondary sides of transformer checked for resistance	_____
Transformer reinstalled or replaced as required	_____
Repair log complete with problems noted	_____

A. Tools and materials

Washer with service literature as selected by instructor
Control panel service literature
Standard hand tools and tool box
VOM
Repair log (attached)
Safety glasses

B. Routine 1—Run self-diagnostic tests on a control panel

- ☐ 1. Sign on your repair log, and consult service literature for recommended troubleshooting routine.

Note: Some microprocessors have self-diagnostic capabilities. Consult service literature to determine if microprocessor board is capable of self-diagnostic tests. If board is capable of self-diagnostics, complete self-diagnostic procedure according to instructions in service literature.

Job Sheet 4

- ☐ 2. Troubleshoot board following procedures in service literature.
- ☐ 3. If self-diagnostics or troubleshooting procedure indicate board is normal, skip the remaining steps in this Routine and go on to Routine 2.
- ☐ 4. If self-diagnostics or troubleshooting indicate board is defective, continue routine to remove and replace board.
- ☐ 5. Put on safety glasses.
- ☐ 6. Disconnect washer power cord.
- ☐ 7. Locate the control panel and open for access according to instructions in service literature.
- ☐ 8. Remove control panel according to instructions in service literature.
- ☐ 9. Disconnect microprocessor board and remove according to instructions in service literature.
- ☐ 10. Install new microprocessor board and connect according to instructions in service literature.
- ☐ 11. Reinstall control panel according to instructions in service literature.
- ☐ 12. Plug in washer and check new control panel.
- ☐ 13. If self-diagnostics indicate that board is normal, sign off repair log and continue testing control panel according to procedure in Routine 2.

C. Routine 2—Check touchpad

- ☐ 1. Sign on your repair log and put on safety glasses.
- ☐ 2. Disconnect washer power cord.
- ☐ 3. Locate the control panel and open for access according to instructions in service literature.
- ☐ 4. Remove control panel according to instructions in service literature.
- ☐ 5. Disconnect microprocessor board and remove from control panel according to instructions in service literature.

Job Sheet 4

- ☐ 6. Using VOM check touchpad for correct resistance with pads pressed and open, according to instructions in service literature. Record the connections and your findings in the space below:

Note: The touchpad is connected to the microprocessor board by a ribbon connector that contains conductive strips. The number of strips and their contacts vary by make and model of washer. Consult appropriate service literature to determine proper contacts and resistance readings.

- ☐ 7. Reinstall or replace touchpad as required according to instructions in service literature and sign off repair log.

D. Routine 3—Check transformer

- ☐ 1. Sign on repair log and put on safety glasses.
- ☐ 2. Disconnect washer power cord.
- ☐ 3. Consult service literature for location of transformer.
- ☐ 4. Locate transformer and remove according to instructions in service literature.
- ☐ 5. Using VOM, check primary side of transformer for continuity and resistance as specified by service literature. Record your findings in the space below:

- ☐ 6. Using VOM, check secondary side of transformer for continuity and resistance as specified by service literature. Record your findings in the space below:

Job Sheet 4

- ☐ 7. Using VOM, check voltage on primary side of transformer as specified by service literature. Record your findings in the space below:

Caution: Live voltage checks require extreme caution. Always make certain that power cord to dryer is disconnected when you are connecting or disconnecting VOM leads.

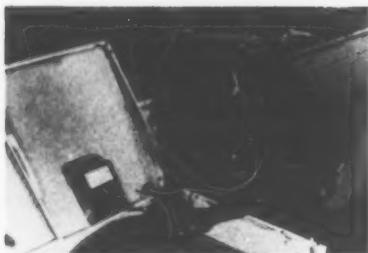
- ☐ 8. Using VOM, check voltage on secondary side of transformer as specified by service literature. Record your findings in the space below:
- ☐ 9. Disconnect washer power cord.
- ☐ 10. Reinstall or replace transformer as required, according to instructions in service literature.
- ☐ 11. Have your instructor check your work.
- ☐ 12. Sign off your repair log and return tools and material to proper storage.

**Automatic Washers
Unit 7****Job Sheet 4****Repair Log**

Your name _____ Date _____

	Date	Time On	Time Off
Routine 1—Run self diagnostic			
Routine 2—Check touchpad			
Routine 3—Check transformer			

Note any special problems you encountered in any of your troubleshooting routines:



Automatic Dryers

Unit 8

Objective Sheet

Unit Objective

After completing this unit, the student should be able to install an automatic dryer, troubleshoot a Whirlpool/Kenmore automatic dryer for typical malfunctions, troubleshoot a GE/Hotpoint automatic dryer for typical malfunctions, and troubleshoot a microprocessor control panel for typical malfunctions.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to automatic dryers with their correct definitions.
2. Match major components with their functions in an automatic dryer.
3. Arrange in order the steps in automatic dryer operation.
4. Complete statements about thermostats and their functions in a dryer.
5. Complete statements about troubleshooting a dryer that will not run.
6. Select true statements about troubleshooting a dryer that will run but not heat.
7. Complete statements about troubleshooting a dryer when the motor runs but the drum will not rotate.
8. Complete statements about troubleshooting a dryer that runs but will not shut off.
9. Select true statements about troubleshooting a dryer that runs and heats but will not dry clothes.
10. Match other dryer problems with their solutions.
11. Complete statements about troubleshooting gas valves and igniters on gas dryers.
12. Match special gas dryer problems with their solutions.
13. Install an automatic dryer. (Job Sheet 1)
14. Troubleshoot a Whirlpool/Kenmore automatic dryer for typical malfunctions, (Job Sheet 2)

Objective Sheet

15. Troubleshoot a GE/Hotpoint automatic dryer for typical malfunctions, (Job Sheet 3)
16. Troubleshoot a microprocessor control board for typical malfunction. (Job Sheet 4)

**Automatic Dryers
Unit 8**

Information Sheet

1. Terms and definitions

- a. **Automatic Dryer**—An appliance designed to dry wet clothes in a heat, air flow sequence in a drum that tumbles clothes as it rotates under control of a timer
- b. **Centrifugal**—The force that impels something outward from a rotating center
- c. **Cycle**—One complete series of events that completes a procedure
- d. **Pilot burner**—A continuous small flame used in gas appliances to ignite the gas burner (also called a pilot light)
- e. **Purging**—Any procedure that cleans or removes obstructions such as removing air from a gas line

2. Major components and their functions in an automatic dryer

- a. **Timer**—The electromechanical brain of an automatic dryer that controls the sequence of functions
- b. **Motor**—Turns the drum, controls the heat circuit, and drives the blower
- c. **Heat source**—An electric dryer uses an electric heating element and a gas dryer uses a gas valve and burner assembly
- d. **Thermostats**—Devices that sense temperature and open or close to energize or de-energize the heat circuit

3. Steps in automatic dryer operation

- a. When the dryer starts, timer contacts energize the drive motor circuits.
- b. Through a series of motors or belts, the drive motor rotates the drum and causes clothes inside to tumble.
- c. As the drum rotates, air is circulated into the drum to provide proper heat.

Note: Some dryers have a fan to provide proper air flow.
- d. In a normal cycle, after the motor circuits are energized, another set of contacts in the timer energize the dryer heat circuit.

Information Sheet

- e. The drying cycle runs for a selected length of time and is controlled by the drive motor.

Note: Having the dryer heat circuit controlled by the drive motor starting switch is a safety feature that insures that air flow and drum rotation should start before the heat circuit is energized, and this prevents overheating on both gas and electric dryers.

- f. During the last five minutes, the starting switch circuit opens, heat stops and dissipates, and cooler air flows through the clothes as the tumbling action continues until the cycle is complete.

Note: Most models refer to this final part of the cycle as "cool down."

4. Thermostats and their functions in a dryer

- a. Cycling thermostats in a dryer help maintain a constant heat level inside the drum when clothes are tumbling.
- b. The safety or limiting thermostat shuts the dryer heat circuit off when there is evidence the dryer may overheat.
- c. Cycling thermostats are mounted in or on the air exhaust duct so they can sense both the temperature and moisture level of the air in the drum.
- d. As the temperature in the drum reaches the limits of a cycling thermostat setting, the thermostat de-energizes the heat circuit and will remain open until the air cools sufficiently, and then close to energize the circuit again.

Note: This may also complete a circuit to the timer.

- e. The number of cycling thermostats in a dryer may vary, but many have low heat, medium heat, and high heat thermostats to provide the user with temperatures for a variety of fabrics.

5. Troubleshooting a dryer that will not run

- a. Make sure the dryer is plugged into a proper power source, and then check the branch circuit control.
- b. Check for loose wires at terminals and run a continuity check on the circuitry to make sure there are not broken wires.
- c. Check for a faulty door switch by first making sure the door is properly shut and then running a continuity check on the door switch, and replace as required.
- d. Check motor wiring and motor centrifugal switch, and replace motor or switch as required.

- e. Check the timer and timer circuitry and replace the timer motor or the timer as required.

6. Troubleshooting a dryer that will run but not heat

- a. Check for loose wires on terminals and run a continuity check to make sure there are no broken wires.
- b. On an electric dryer, check for a proper 240V power supply.
- c. Check for defective thermostats and replace as required.
- d. Check for a wrong setting on the heat switch or check the heat switch itself and replace as required.

Note: This check applies only to dryer models with temperature selector switches.

- e. Check timer and timer wiring and replace timer motor or entire timer as required.
- f. Check the centrifugal switch, if it is the type of motor that has one, and replace as required.
- g. Check for an open heater element and replace heater element as required.
- h. On a gas model, check the gas supply and make sure the gas supply valve is open.
- i. If the gas model has a pilot light that is out, purge the line as indicated on the dryer plate directions and relight the pilot.
- j. Check for a defective solenoid coil in the gas valve by testing the coil for an open circuit, and replace the solenoid, if required, or the entire gas valve.

Note: On some models solenoids can be replaced, and the voltage reading at the valve should be indicated on the dryer plate, but this voltage is usually 120V.

- k. Check for a defective flame switch.
- l. Check for a malfunctioning igniter.

7. Troubleshooting a dryer when the motor runs but the drum will not rotate

- a. Check for a slipping or broken belt and adjust or replace as required.
- b. Check for a loose pulley and tighten the pulley on the motor shaft.
- c. Check for foreign objects that may be obstructing drum movement and remove them.

Information Sheet

- d. Check for a frozen bearing and replace as required.
- e. Check for tension and adjust or replace.

8. Troubleshooting a dryer that runs but will not shut off

- a. Check to see if one side of the branch circuit control is tripped open.

Note: When a circuit overload occurs and the motor side or L₁ side of the line control fuse or breaker trips open, the motor will continue to run through L₂ or in series with the motor heating circuit.

- b. Check for a defective timer and replace timer motor or timer as required.

9. Troubleshooting a dryer that runs and heats but will not dry clothes

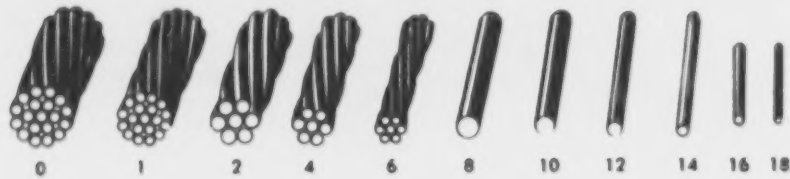
- a. Check for a clogged lint screen and clean or replace as required.
- b. Check for a clogged exhaust vent.
- c. Check for incorrect heat or timer setting and reset as required.
- d. Check for a leaky door seal and if the door seal leaks air, replace it.
- e. Check for leaky drum seals and replace as required.
- f. Check for a fan or pulley loose on its shaft and tighten as required to restore good air motion in the drum.
- g. Check for defective operating thermostats, and if any of the thermostats are cycling too soon or too late, replace them.

Note: Checking thermostats requires using a temperature tester as outlined in Job Sheet 2.

- h. Find out if clothes were too wet when placed into the drum, and encourage customer to make sure clothes are properly wrung out before placing them in the dryer.

Note: Excessively wet clothes indicates the customer may also have a problem with an automatic washer, and a sharp repair technician will suggest that the washer may also need repair.

- b. The AWG number grows smaller as the size of the wire increases.



- c. The major insulation types required around major appliances are:
- (1) RHW--Moisture and heat-resistant rubber for dry and wet locations where operating temperatures do not exceed 167°F
 - (2) THW--Moisture and heat-resistant thermoplastic for dry and wet locations where operating temperatures do not exceed 194°F
 - (3) AA--A special wire for electric ranges because it has a braided asbestos covering and can operate at temperatures up to 392°F
- d. When reading wire sizes, the first number is the AWG size and the second number indicates how many conductors are in the wire.
- Example: 10/3 is a 10-gauge wire with 3 conductors.
- e. The maximum amperage a wire can safely carry is known as ampacity, and low ampacity wires should never be used for high ampacity applications.

AWG#	Ampacity
14	15
12	20
10	30
8	45
6	65
4	85
2	115
1	130
0	150
00	175
000	200

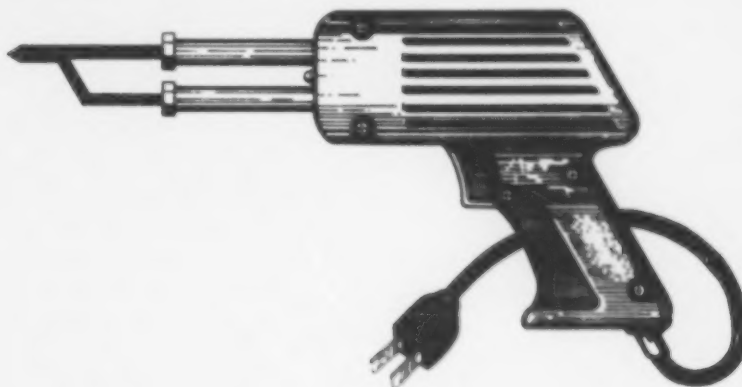
- f. Never replace an AWG wire with a smaller wire because it could cause a malfunction and create a fire hazard.

Information Sheet

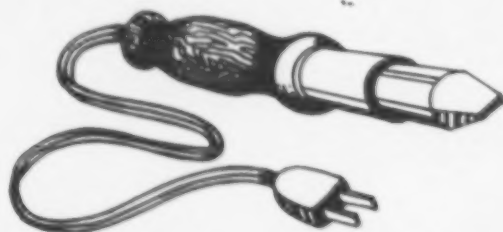
A receptacle for an electric range has a #8 AWG wire for ground and #6 AWG wires for both the hot leads; using #10 wire for the connection would not meet the NEC code, but #10 AWG wire is acceptable on a dryer receptacle because of the lower amperage a dryer demands.

15. Soldering tools

- a. A 150 to 250 watt soldering gun is recommended for connectors and circuits rated 30 to 50 amps or greater.



- b. Large soldering irons of 40 to 150 watts are suitable for connectors and circuits rated 10 to 30 amps.



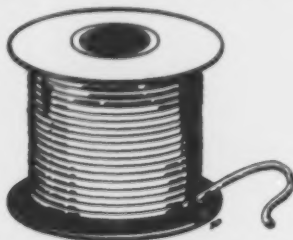
- c. A pencil iron rated 20 watts or less may be required for special applications such as printed circuit boards or where space will not permit a larger iron.



- d. Soldering poses burn hazards, but the greater danger is potential eye damage, so always wear safety glasses when soldering.

16. Resin-core solder and its characteristics

- a. The type of solder used most often around electrical connections is 40/60 resin-core solder.
- b. The 40/60 means the solder is an alloy of 40% tin and 60% lead.
- c. The flux required to clean metal and promote fusion is placed inside the core of resin-cored solder.
- d. Resin-core solder comes in handy rolls that are convenient to store and carry.



- e. Resin-core solder is noncorrosive and suitable for almost all work around major appliances.
- f. When using resin-core solder, clean surface(s) to be soldered, apply heat to the surfaces, and then run the strand of solder over the heated surface(s).

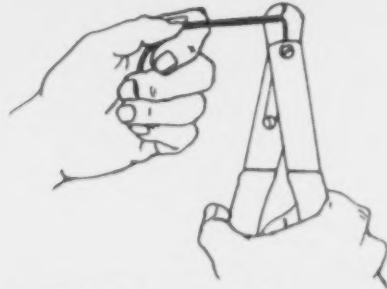
17. Solid wire solder and its characteristics

- a. Solid wire solder is a popular 40/60 alloy for use in sweating or swaging joints of tubing.
- b. Because solid wire solder has no flux core, a paste flux must be used with it.
- c. The procedure for using solid wire solder is:
 - (1) clean surfaces to be soldered,
 - (2) apply soldering flux to both surfaces,
 - (3) apply heat to the parts to be soldered, not to the solder itself, and
 - (4) apply the solder to the heated parts and allow it to melt onto the parts.

Information Sheet

18. Steps in wire stripping

- a. Place the wire in the proper slot in the wire stripper and work the stripper back and forth until a cut is made around the entire insulation.



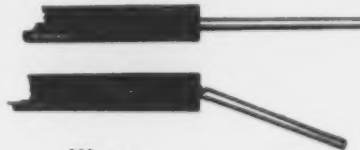
- b. Hold the wire tight with one hand and use the other hand to gently move the insulation back and forth until the cut breaks clean and unwanted insulation can be pulled off.



- c. Taper the insulation with a knife to increase the wire's flexibility because straight cut insulation creates a force point that can cause a wire to break.



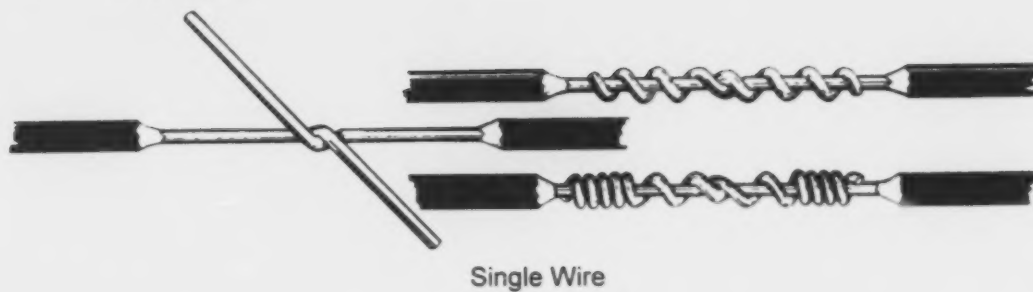
Right



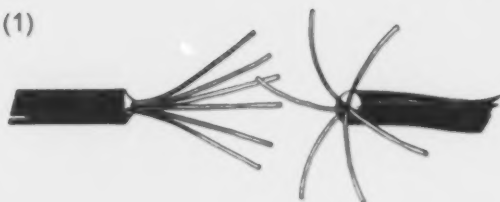
Wrong

19. Types of splices

a. Simple splice



(1)



(2)



(3)

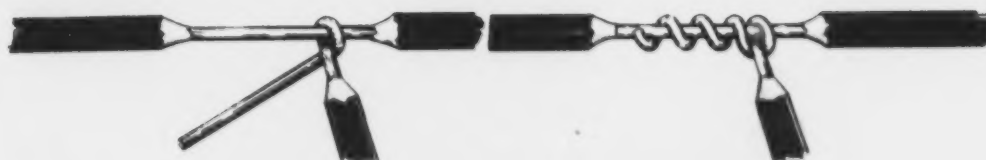


(4)



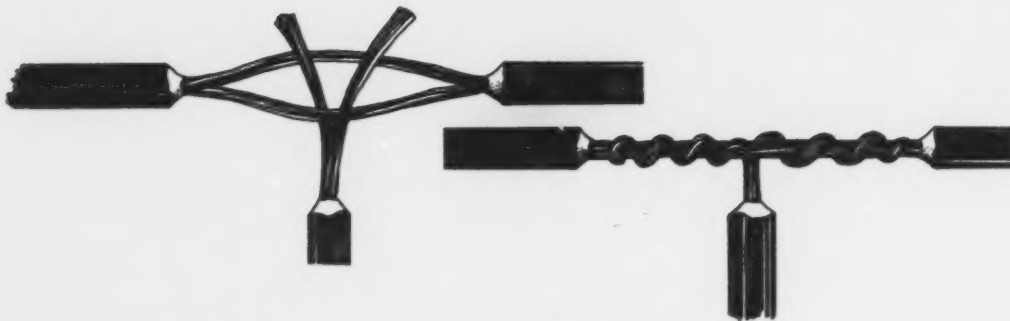
Stranded Wire

b. Simple tap



Single Wire

Information Sheet

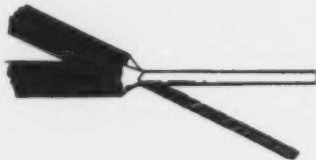


Stranded Wire

c. Pigtail splice



(1)



Single Wire

(2)



(3)

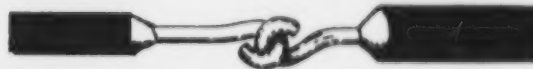


(4)



Single Wire to Stranded Wire

d. Hook splice



20. Guidelines for connections at screw terminals

- a. Wire should be attached at a screw terminal so that the loop lies in the direction the screw turns.



Right



Wrong

- b. Wire should loop the screw a little less than one full turn, but excessive loops are not recommended.

21. Guidelines for good soldered splices

- a. Wires to be spliced must be bright and clean at the point of connection.
- b. Connecting points must be tight so solder will solidify without wire movement.



- c. Wire should be coated with electric soldering paste, and then soldered so the solder melts and flows into every crevice of the splice.



- d. Entire splice area should be covered with water-proof plastic tape.



22. Guidelines for using soldering connectors and terminals

- a. Solderless connectors should be used according to their color codes, and a connector for a lighter gauge should never be used on a wire of a heavier gauge.
- b. Screw-on connectors work well on pigtail splices, and they require no taping because they are made of insulating materials.



Information Sheet

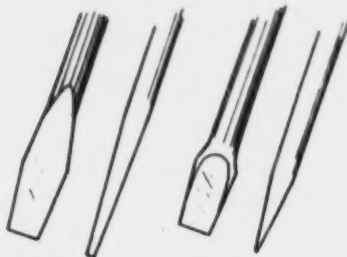
- c. Crimp-on terminal lugs should not leave a gap between the insulation and the lug, and if there is a gap, a plastic sleeve should be added to cover the bare wire.



23. Proper care and use of hand tools

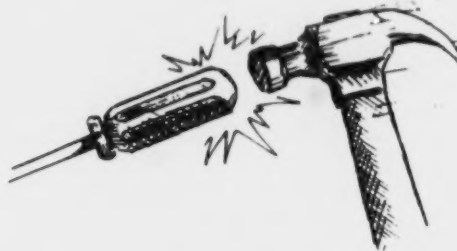
a. Screwdrivers

- (1) Do not hammer or pry with screwdrivers.
- (2) Worn Phillips screwdrivers should be discarded, but flat blade screwdrivers can be useful as long as the tip can be reground square.



Right

Wrong

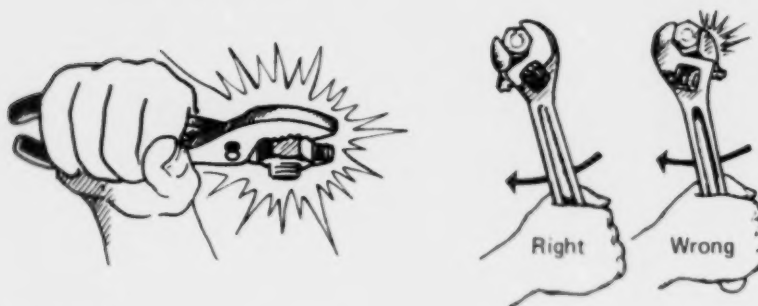


No

b. Wrenches and pliers

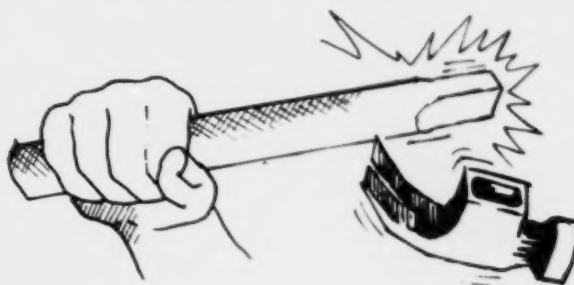
- (1) Do not hammer on wrenches or hammer with wrenches.
- (2) Use adjustable wrenches so that the large jaw is opposite the direction of force.
- (3) When pulling on an adjustable wrench, be careful not to hit yourself in the chest or head, and when pushing on an adjustable wrench, hold your hand palm-flat on the handle so you won't accidentally scar your knuckles.
- (4) Do not use pliers in place of a wrench, especially on brass fittings.

- (5) Use pliers with insulated handles when working around electrical circuits and components.



c. Hammers

- (1) Never use a hammer with a loose handle.
 (2) Use all hammers for their intended purpose.

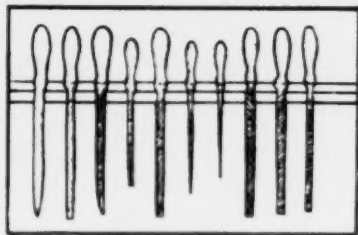
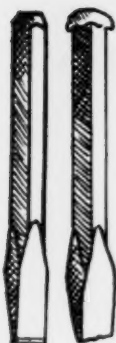


d. Punches, chisels, and files

- (1) Keep chisel cutting edges sharp.
 (2) Keep chisel heads properly dressed, and never strike a chisel that has a mushroomed head.
 (3) Files become dull if stacked in a drawer, so hang them up.

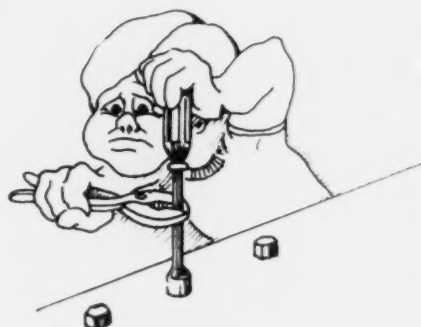
Information Sheet

- (4) Do not hammer or pry with a file because they are brittle and break easily.



e. Socket sets and nut drivers

- (1) Do not use a cheater bar to gain greater leverage on the handle of a ratchet because it will strip the ratchet gears.
- (2) Do not use a cheater bar on a thin wall socket because the socket will break.
- (3) Nut drivers should be used for hand-tight nuts, bolts, and screws, but do not use pliers to increase leverage.



24. Guidelines for using other tools and equipment

- a. Cords for drop lights should not be run over by appliance dollies or placed where objects with metal edges may be placed on them.
- b. Handle levels with care because once they are dropped they are usually inaccurate.
- c. Do not apply too much pressure on a hex wrench or it may break or round out the socket in the set screw.

Information Sheet

- d. Never use oxyacetylene equipment without proper instruction or without permission.
- e. Keep safety glasses in a case when they are not in use so they'll stay clean.

Note: If someone had to take time to clean a pair of safety glasses, they might have a tendency just to forget them.

- f. Never point a compressed air nozzle at another person, and never use compressed air when it might spray dirt or metal particles at someone nearby.

25. Eye protection

- a. Wear safety glasses at all times in the shop area.
- b. Blow compressed air away from you when using it for cleaning.
- c. Wear a face shield when working with grinding tools.
- d. If you get cleaning solvent on your hands, wash them with soap and water to avoid the possibility of accidentally rubbing your eyes.
- e. Know the location of the nearest eye flush station.

Tools, Materials, and Test Instruments
Unit 6

Student Supplement 1—Basic Hand Tools



Adjustable Pliers



Standard Screwdriver Set



Needlenose Pliers



Phillips Screwdriver Set



Lineman's (sidecutting) Pliers



Slip-Joint Pliers



Nut Driver



Wire Strippers
(Electrician's 6-in-1 tool)



Internal Snap-Ring Pliers



Locking Pliers

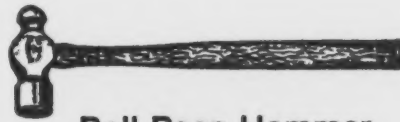


External Snap-Ring Pliers

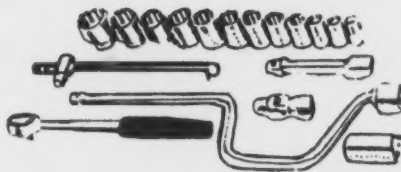
Student Supplement 2—More Basic Hand Tools



Aviation Snips



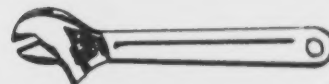
Ball Peen Hammer



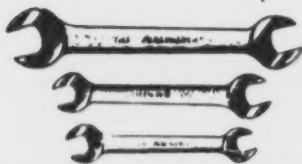
Socket Set and Ratchet



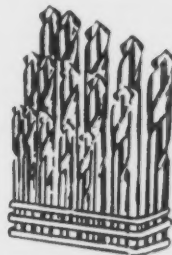
Pipe Wrench



Adjustable Wrench



Open End Wrenches



Drill Bits



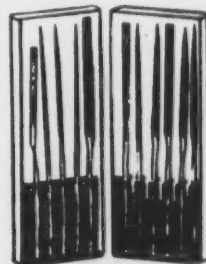
Drill



Chisel



Punch



Files

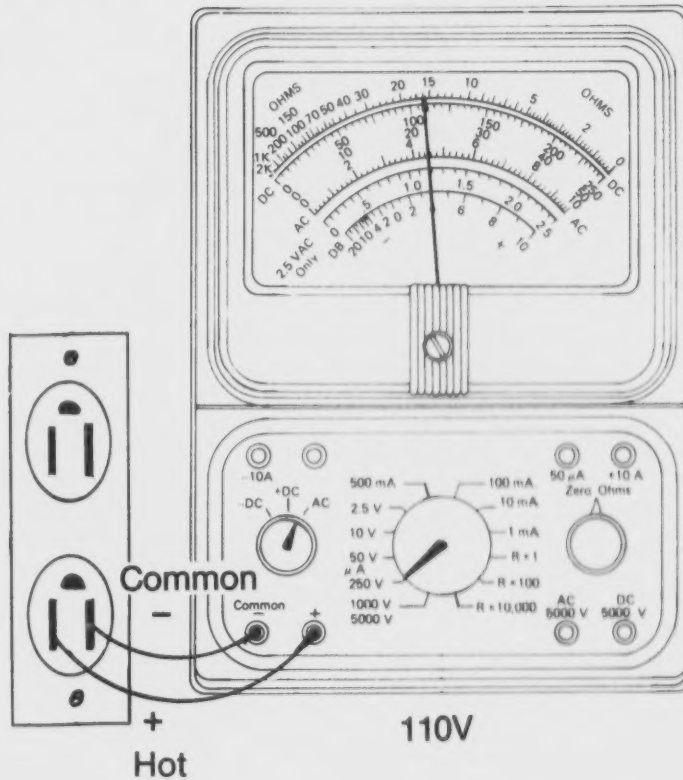


Hex Wrenches

Tools, Materials, and Test Instruments
Unit 6

MAR-183

Student Supplement 3—Measuring Voltage at a Receptacle

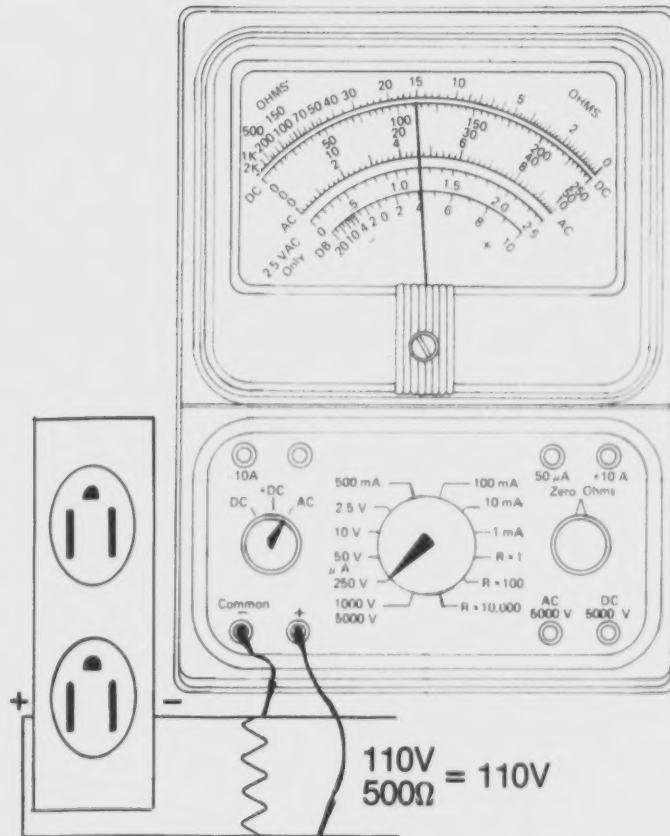


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Tools, Materials, and Test Instruments
Unit 6

MAR-185

Student Supplement 4—Measuring Voltage in a Parallel Circuit

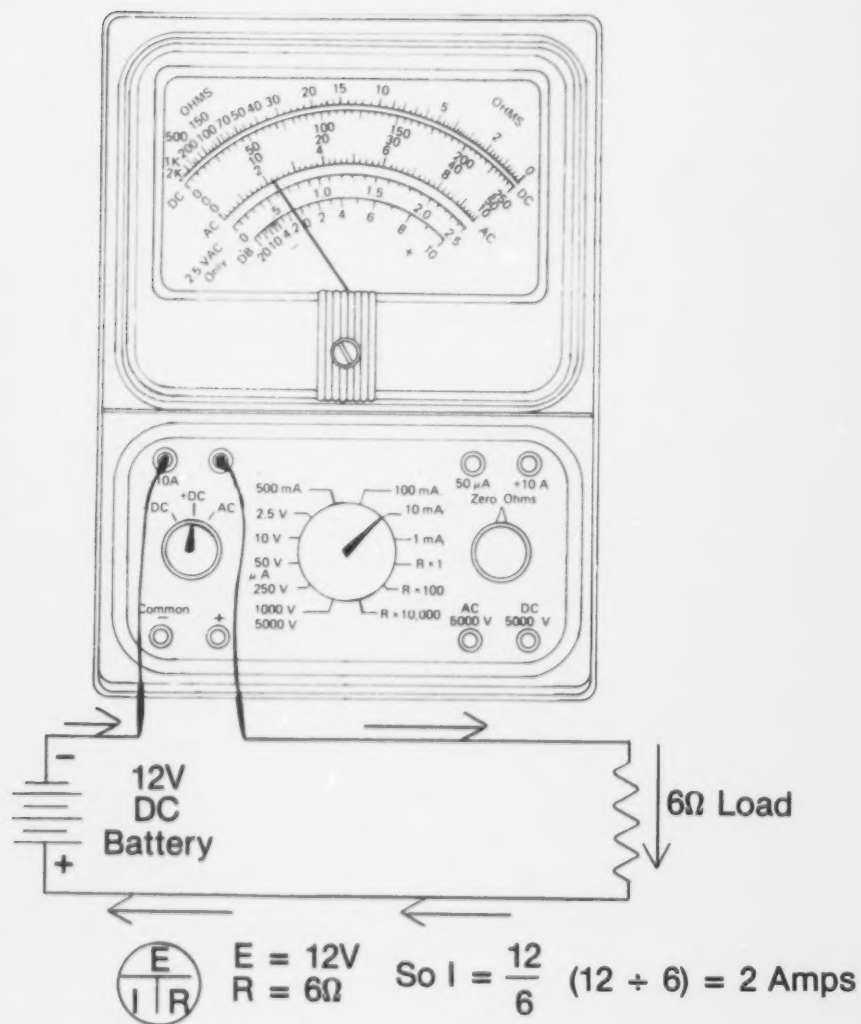


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Tools, Materials, and Test Instruments
Unit 6

MAR-187

Student Supplement 5—Measuring Amperage in a Circuit

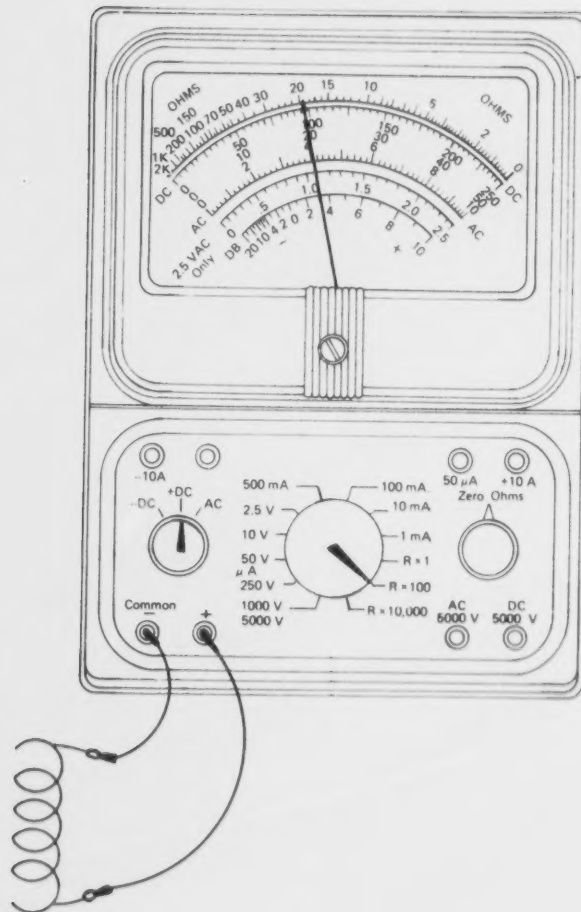


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Tools, Materials, and Test Instruments
Unit 6

MAR-189

Student Supplement 6—Measuring Resistance in a Coil



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Tools, Materials, and Test Instruments
Unit 6

MAR-191

Assignment Sheet 1—Identify Selected Tools

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Number of Identifications attempted	_____
Number of correct identifications	_____

Directions: Your instructor has prepared a display of tools that are each tagged with a number. Examine the tools and write the name of each tool beside the correct number. Add more numbers as needed.

- | | |
|-----------|-----------|
| 1. _____ | 16. _____ |
| 2. _____ | 17. _____ |
| 3. _____ | 18. _____ |
| 4. _____ | 19. _____ |
| 5. _____ | 20. _____ |
| 6. _____ | 21. _____ |
| 7. _____ | 22. _____ |
| 8. _____ | 23. _____ |
| 9. _____ | 24. _____ |
| 10. _____ | 25. _____ |
| 11. _____ | 26. _____ |
| 12. _____ | 27. _____ |
| 13. _____ | 28. _____ |
| 14. _____ | 29. _____ |
| 15. _____ | 30. _____ |

Tools, Materials, and Test Instruments
Unit 6

MAR-193

Job Sheet 1—Test Electrical Receptacles for Correct Voltage

Name _____ Attempt Number _____

Date _____ Overall Rating _____

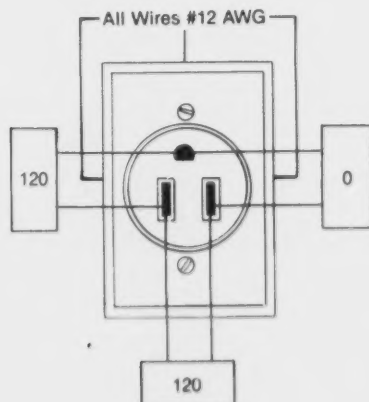
Evaluation Criteria	Rating
120V receptacle correctly tested and recorded	_____
240V range receptacle correctly tested and recorded	_____
240V dryer receptacle correctly tested and recorded	_____

A. Tools and materials

Wall receptacle with 120V supply
Wall receptacle for 240V range supply
Wall receptacle for 240V dryer supply
VOM
Pencil and paper
Safety glasses

B. Routine 2—Checking a 120V receptacle

- ☐ 1. Put on safety glasses and set the VOM to measure voltage at 250V.
- ☐ 2. Make sure the selector switch is set for AC.
- ☐ 3. Place one VOM test lead into each of the slotted openings in the receptacle.

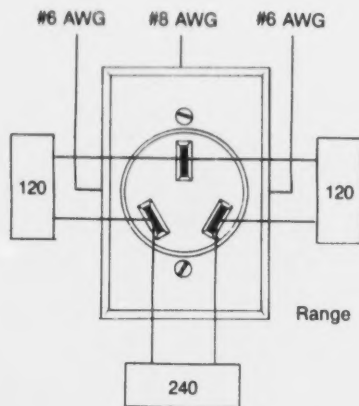


Job Sheet 1

- ☐ 4. Check your meter and record the reading _____.
- ☐ 5. Place one VOM lead in the left slotted opening and the other VOM lead in the round hole at the top of the receptacle.
- ☐ 6. Check your meter and record the reading _____.
- ☐ 7. Place one VOM lead in the right slotted opening and the other VOM lead in the round hole at the top of the receptacle.
- ☐ 8. Check your meter and record the reading _____.
- ☐ 9. Compare the reading in Step 8 with the reading from Step 6.
- ☐ 10. Have your instructor check your findings.
- ☐ 11. Make all voltage checks again if your findings vary at all from the values shown in the Routine 1 illustration.

C. Routine 2—Checking a 240V range receptacle

- ☐ 1. Leave the VOM set to measure 250V and the range selector set at AC.
- ☐ 2. Place one VOM test lead into each of the outside slotted openings in the receptacle.



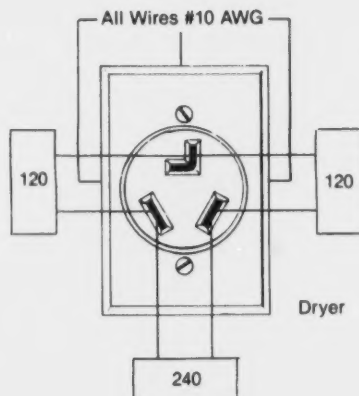
- ☐ 3. Check your meter and record the reading _____.
- ☐ 4. Place one VOM lead into the left slotted opening and the other VOM lead in the center slotted opening.
- ☐ 5. Check your meter and record the reading _____.

Job Sheet 1

- ☐ 6. Place one VOM lead into the right slotted opening and the other VOM lead in the center slotted opening.
- ☐ 7. Check your meter and record the reading _____.
- ☐ 8. Compare the reading in Step 7 with the reading from Step 5.
- ☐ 9. Have your instructor check your findings.
- ☐ 10. Make all voltage checks again if your findings vary at all from the values shown in the Routine 2 illustration.

D. Routine 3—Checking a 240V dryer receptacle

- ☐ 1. Leave the VOM set to measure 250V and the range selector set at AC.
- ☐ 2. Place one VOM lead into each of the outside slotted openings in the receptacle.



- ☐ 3. Check your meter and record the reading _____.
- ☐ 4. Place one VOM lead into the left slotted opening and the other VOM lead in the center L-shaped slot.
- ☐ 5. Check your meter and record the reading _____.
- ☐ 6. Place one VOM lead into the right slotted opening and the other VOM lead into the center L-shaped slot.
- ☐ 7. Check your meter and record the reading _____.
- ☐ 8. Compare the reading in Step 7 with the reading from Step 5.
- ☐ 9. Have your instructor check your findings.

Job Sheet 1

- ☐ 10. Make all voltage checks again if your findings vary at all from the values shown in Routine 3 illustration.
- ☐ 11. Discuss with your instructor the differences in the wire gauges used for each of the receptacles checked.
- ☐ 12. Clean up area and return tools and materials to proper storage.

Comments: _____

Tools, Materials, and Test Instruments
Unit 6

MAR-197

Job Sheet 2—Use a Clamp-On Ammeter to Test for High and Low Amperages
on a Fan Motor and a Light Bulb

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Clamp-on probe properly used over only one wire	_____
High amperage check made and recorded	_____
Low amperage check made and recorded	_____

A. Tools and materials

Fan motor or other acceptable motor
100W light bulb
Clamp-on ammeter
Pencil and paper
Safety glasses

B. Routine 1—Checking high amperage

- ☐ 1. Put on safety glasses and plug motor into power source.
- ☐ 2. Determine current-carrying conductor.

Note: If necessary check schematic.

- ☐ 3. Clamp ammeter probes over current-carrying conductor.

Note: Do not clamp probes over two or three wires, make certain they are clamped over only one conductor.

- ☐ 4. Set the rotary scale for the highest amperage scale first, then move down as necessary to make your reading.
- ☐ 5. Determine amp reading from proper scale and record the reading: _____.
- ☐ 6. Have your instructor check your work.

Job Sheet 2

C. Routine 2—Checking low amperage

- ☐ 1. Plug 100-watt light bulb into power source.

Note: Conductor lead to load should have enough play that it can be wrapped around one of the meter clamps.

- ☐ 2. Clamp ammeter probes over current-carrying conductor.
- ☐ 3. Set the rotary scale for the highest amperage scale first, then move down as necessary to make your reading.
- ☐ 4. Unclamp the probe and loop the conductor three times around one of the meter clamps.
- ☐ 5. Determine amp reading from the proper scale and record your reading: _____.
- ☐ 6. Divide reading by the number of loops (three) you made in the conductor.
- ☐ 7. Have your instructor check your work.
- ☐ 8. Clean up area and return tools and materials to proper storage.

Comments: _____

Tools, Materials, and Test Instruments
Unit 6

MAR-199

Job Sheet 3—Make a Continuity Check of a Magnetic Control Assembly
From an Automatic Washer

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Check made with VOM at R x 1 scale on both solenoids	_____
Check made with VOM at R x 100 scale on both solenoids	_____
Meter deflections correctly recorded	_____
Readings compared with 525 ohms	_____

A. Tools and materials

Magnetic assembly from a Whirlpool/Kenmore washer
VOM
Pencil and Paper
Safety glasses

B. Procedure

- ☐ 1. Put on safety glasses
- ☐ 2. Place the magnetic assembly on a work bench.
- ☐ 3. Set the VOM at the R x 1 scale.
- ☐ 4. Place the VOM probes on the terminals of the right or left solenoid.
- ☐ 5. Note the meter deflection and record it below:

R x 1 _____

Note: If the deflection is too small to read, write none.

- ☐ 6. Set the VOM to the R x 100 scale.

Job Sheet 3

- ☐ 7. Note the meter deflection and record it below:

R x 100 _____

- ☐ 8. Check your finding to see how close it is to 525 Ω .

- ☐ 9. Repeat the procedure for the other solenoid, but start with the R x 100 scale.

- ☐ 10. Record your findings.

R x 100 _____

R x 1 _____

- ☐ 11. Have your instructor check your findings.

- ☐ 12. Clean up area and return tools and materials to proper storage.

Comments: _____

Tools, Materials, and Test Instruments
Unit 6

MAR-201

Job Sheet 4—Splice Electrical Conductors to Acceptable Service Standards

Name _____ Attempt Number _____

Date _____ Overall Rating _____

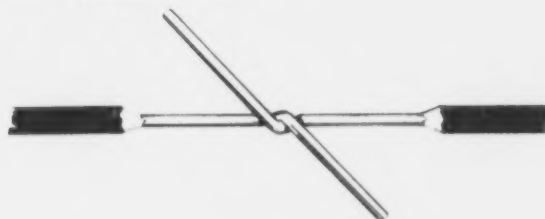
Evaluation Criteria	Rating
Simple splices correctly made, soldered, and taped	_____
Pigtail splices correctly made, soldered, and taped	_____
Tap splices correctly made, soldered, and taped	_____

A. Tools and materials

Soldering gun
60/40 resin-core solder
Wire strippers
Utility knife
Needlenose pliers
Slip-joint pliers
Diagonal pliers
Diagonal cutters
Sponge
Plastic tape
Safety glasses

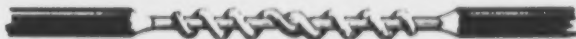
B. Routine 1—Splicing and soldering simple splices

- ☐ 1. Select two pieces of single wire conductor.
- ☐ 2. Put on safety glasses and strip 2" insulation from the end of each conductor.
- ☐ 3. Bevel the end of each insulation cut.



Job Sheet 4

- ☐ 4. Twist conductors around each other with enough turns to insure a sturdy splice.



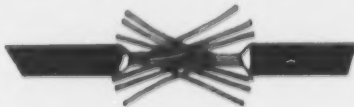
- ☐ 5. Place the spliced wires on a work bench.
- ☐ 6. Heat the soldering gun tip.
- ☐ 7. Clean the tip of the soldering gun with a sponge.
- ☐ 8. Apply a small amount of solder to the tip.
- ☐ 9. Begin at one end of the splice and apply solder from the top as you move the tip of the soldering gun slowly along the underside of the splice.



- ☐ 10. Move the soldering tip slowly enough that the solder melts evenly onto the splice and runs down so that it fills all crevices where conductors meet.
- ☐ 11. Permit soldered splice to cool.
- ☐ 12. Have your instructor check your work.
- ☐ 13. Tape complete splice with plastic tape in a spiral wrap that slightly overlaps to assure a complete covering.



- ☐ 14. Repeat the procedure as required to make a simple splice on stranded wire.



- ☐ 15. Have your instructor check your work.

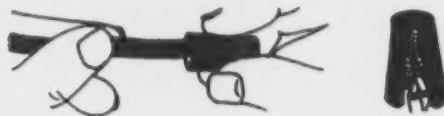
C. Routine 2—Making pigtail splices

- ☐ 1. Select two more pieces of single wire conductor.
- ☐ 2. Strip and bevel conductors as previously outlined.

506

Job Sheet 4

- ☐ 3. Place conductors side by side and start a twist on the end with your fingers or pliers, if required.
- ☐ 4. Place a screw-on cap of the proper size over the end of the two conductors and screw it clockwise down until it completely covers the bare conductors.



- ☐ 5. Have your instructor check your work.
- ☐ 6. Select two more pieces of single wire conductor and strip and bevel as previously outlined.
- ☐ 7. Prepare another pigtail splice, but this time, twist the wires out from the bevel around each other to form the pigtail.



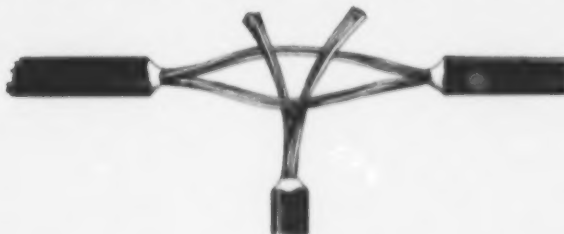
- ☐ 8. Heat the soldering tip again, clean it, tin it, and solder the pigtail with the same procedure used to solder the simple splice.
- ☐ 9. Permit the pigtail to cool.
- ☐ 10. Have your instructor check your work.
- ☐ 11. Tape the pigtail as previously outlined.
- ☐ 12. Repeat the procedure for splicing and soldering a single wire conductor and a stranded wire conductor into a pigtail.
- ☐ 13. Have your instructor check your work.
- ☐ 14. Tape the pigtail as previously outlined.

D. Routine 3—Making tap splices

- ☐ 1. Select two more pieces of single wire conductor.

Job Sheet 4

- ☐ 2. Strip about 1 ½" from the center of one conductor and bevel the insulation edges on both sides.
- ☐ 3. Strip one end of the other conductor and bevel as previously outlined.
- ☐ 4. Place the free end of the last conductor prepared at about the center of the first conductor and wrap the tap onto the bare space in the first conductor.



- ☐ 5. Heat the soldering tip again, clean it, tin it, and solder the tap with the same procedure previously used.
- ☐ 6. Permit the splice to cool.
- ☐ 7. Have your instructor check your work.
- ☐ 8. Tape the tap splice as previously outlined.
- ☐ 9. Repeat the procedures for splicing and soldering a stranded wire tap.



- ☐ 10. Permit the soldered splice to cool.
- ☐ 11. Have your instructor check your work.
- ☐ 12. Tape the tap splices as previously outlined.
- ☐ 13. Clean up area and return tools and equipment to proper storage.

Comments: _____

Tools, Materials, and Test Instruments
Unit 6

MAR-205

Job Sheet 5—Use a VOM for a Quick Capacitor Check

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Capacitor discharged as safety precaution	_____
VOM leads placed on capacitor terminals for reading	_____
VOM leads reversed on capacitor terminals for reading	_____
Capacitor evaluated as good, shorted, or open	_____

A. Tools and materials

Capacitor(s) as selected by instructor
VOM
Pencil and paper
Safety glasses

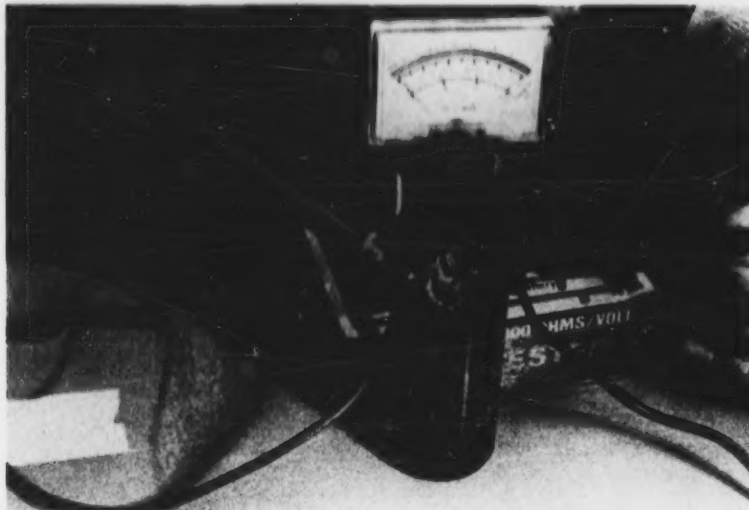
B. Procedure

- ☐ 1. Put on safety glasses and make sure the capacitor has been discharged if it has been recently energized.

Note: Check with your instructor for a safe discharging procedure.

Job Sheet 5

- ☐ 2. Connect VOM leads in any order to the capacitor terminals.



- ☐ 3. Check the indicator needle for movement about halfway across the scale and then a drop back to zero.
- ☐ 4. Reverse the VOM leads on the capacitor terminals.
- (a) If switching the meter leads back and forth continues to show a noticeable deflection and then a fall back to zero, the capacitor is okay.
 - (b) If there is more than a half-scale deflection and the needle will not return to zero, the capacitor is shorted.
 - (c) If there is no reading at all, the capacitor is open.
- ☐ 5. Record your findings for the first capacitor and repeat the procedure for other capacitors that your instructor may supply.
- ☐ 6. Record all findings.
- ☐ 7. Have your instructor check your work.
- ☐ 8. Clean up area and return tools and materials to proper storage.

Comments: _____

Automatic Washers

Unit 7

Objective Sheet



Unit Objective

After completing this unit, the student should be able to install an automatic washer, troubleshoot a Whirlpool/Kenmore automatic washer for typical malfunctions, and troubleshoot a GE/Hotpoint automatic washer for typical malfunctions. The student should demonstrate these competencies by completing the activities in the job sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to automatic washers with their correct definitions.
2. Match major components with their functions in an automatic washer.
3. Arrange in order the steps in a typical automatic washer cycle.
4. Complete statements about fill functions in a normal cycle.
5. Complete statements about agitation functions in a normal cycle.
6. Complete statements about pumpout and spin functions in a normal cycle.
7. Select true statements about guidelines for evaluating automatic washer malfunctions.
8. Arrange in order the steps in validating repairs.
9. Complete statements about troubleshooting a washer that will not fill with water.
10. Select true statements about troubleshooting a washer for improper water level or water temperature.
11. Select true statements about troubleshooting a washer when water will not shut off.
12. Complete statements about troubleshooting a washer that leaks water.
13. Complete statements about troubleshooting when water will not drain from the washer.

Objective Sheet

14. Select true statements about troubleshooting a washer with a motor that will not run.
15. Complete statements about troubleshooting a washer that will not agitate.
16. Complete statements about troubleshooting a washer that will not spin.
17. Select true statements about troubleshooting a washer that will not advance or shut off.
18. Select true statements about troubleshooting a washer that leaks oil.
19. Select true statements about troubleshooting a washer that tears clothes.
20. Match other washer problems with ways to correct them.
21. Install an automatic washer. (Job Sheet 1)
22. Troubleshoot a Whirlpool/Kenmore automatic washer for typical malfunctions. (Job Sheet 2)
23. Troubleshoot a GE/Hotpoint automatic washer for typical malfunctions. (Job Sheet 3)
24. Troubleshoot a microprocessor control panel for typical malfunctions. (Job Sheet 4)

**Automatic Washers
Unit 7**

Information Sheet

1. Terms and definitions

- a. **Automatic washer**—An appliance designed to clean dirty clothes in a wash, rinse, and spin-dry sequence controlled by a timer
- b. **Centrifugal**—The force that impels something outward from a rotating center
- c. **Cycle**—One complete performance of a series of events that completes a procedure
- d. **Electromechanical timer**—A timer that consists of a motorized dial and cam that makes electrical connections in a timed sequence following a manual start
- e. **Glazing**—The highly-polished look of hydrocarbon build-up resulting from heat produced by friction between brake shoes and their metal housings
- f. **Microprocessor-based timer**—A timer that uses a printed circuit board to make electronic connections in a timed sequence following user programming with a touchpad
- g. **Reciprocating**—Moving back and forth in an alternating motion

2. Major components and their functions in an automatic washer

- a. **Timer**—An electromechanical or microprocessor-based device started manually or programmed to control the sequence of operations of an automatic washer
- b. **Motor**—Drives or turns the transmission or power train to provide power for agitation and spin motion
- c. **Transmission**—Converts motor power into directional control of agitate and spin functions including reciprocating motion for agitation
- d. **Water pump**—Pumps water from the tub and may also recirculate the water in the tub by pulling it from the bottom of the tub and dumping it back in the top

Note: A single-stage pump only extracts water from a tub, but a two-stage pump extracts water and recirculates it.
- e. **Water pressure/level switch**—Controls water level in the tub when activated by water pressure or a float-type device

3. Steps in a typical automatic washer cycle

- a. First fill
- b. Wash agitation
- c. First pumpout and spin
- d. Second fill
- e. Rinse agitation
- f. Final pumpout and spin

4. Fill functions in a normal cycle

- a. Machine usually fills twice during one cycle.
- b. The first fill is a wash fill with hot, warm, or cold water selected manually or predetermined by timer setting.
- c. The second fill is a rinse fill with warm or cold water only (no hot water) determined by timer setting.
- d. Timer is usually set to automatically direct cold water to the tub during the rinse fill portion of the cycle.

5. Agitation functions in a normal cycle

- a. Machine usually agitates twice during one cycle.
- b. Agitation may be accomplished with reciprocating motion or by rotating a drum.
- c. The first agitation is a wash agitation which may vary from 6 to 18 minutes and is usually accomplished with a high-speed motor setting.
- d. The second agitation is a rinse agitation which may vary from 2 to 6 minutes and is usually accomplished with a high-speed motor setting.
- e. The wash agitation mixes detergent with water and creates action to dislodge and separate soil from clothes.
- f. The rinse agitation separates detergent residue and dislodges separated particles so that they will be removed with pumpout and not settle back onto the clothes.

6. Pumpout and spin functions in a normal cycle

- a. Machine usually pumps out and spins twice in one cycle.
- b. Pumpout is initiated by the timer and regulated by either the water level or water pressure switch.
- c. In most washers, the water pressure switch will not allow the timer to advance until the water has been pumped out to assure that the first spin will last 2 to 4 minutes.
- d. The spin action creates a centrifugal force which literally throws water from the clothes.
- e. The final spin usually lasts at least 4 minutes or longer and is always a high-speed motor function.
- f. On some machines, spray rinse is an added feature of the spin function so that any residue that collects on the clothes during the spin function will be rinsed off and pumped out.

7. Guidelines for evaluating automatic washer malfunctions

- a. Identify the washer brand and model number.

Note: Automatic washers from each manufacturer have problems that are peculiar to that brand, and recognizing the similarities or problems within a brand line can save troubleshooting time.
- b. Ask the customer to explain what the machine is not doing or what the machine is doing wrong.
- c. Take notes as required so you will remember what has been said if the customer should have to leave.
- d. Verify the problem with a physical inspection or run the washer in an attempt to duplicate the problem if running the washer is still practical.

8. Steps for validating repairs

- a. Run the washer through one full normal cycle.
- b. Do not manually advance the timer.

Information Sheet

- c. Make sure the washer:
 - (1) fills properly,
 - (2) agitates effectively,
 - (3) pumps out and spins properly, and
 - (4) shuts itself off.
- d. Double-check for leaks, and
- e. Check the machine for level.

9. Troubleshooting a washer that will not fill with water

- a. Check the obvious first:
 - (1) washer may not be properly turned on.
 - (2) hoses may be kinked.
 - (3) screens in the fill hoses may be clogged.
- b. Make sure a proper water supply is available to the machine.
- c. Check for proper voltage at the mixing valve with a VOM.

NOTE: An alternate check is to put the washer on a "fill" setting, turn the timer on, and feel the valve to see if it vibrates or listen for a humming noise; if the valve vibrates or makes a humming noise, this indicates proper voltage at the mixing valve, but be sure to exercise caution when working with live circuits.

- d. When a mixing valve is energized but still will not admit water, check for obstructions in the valve and remove them.
- e. Run a continuity check on the fill switch and replace as required.
- f. Check the temperature selection switch.
- g. Make sure it is not a timer problem.
- h. Check the lid switch to make sure it is making proper contact.

10. Troubleshooting a washer for improper water level or water temperature

- a. Check for reversed hot and cold water hoses.
- b. Check for the quality of the hot water supply.

Information Sheet

- c. Check for a faulty water level switch.
- d. Check for a faulty thermal element in the mixing valve if it is a thermal type mixing valve.
- e. Check for a faulty temperature selection switch in the control panel or timer.
- f. Check for faulty timer.
- g. If the washer has a spray rinse in the spin portion of the rinse cycle, and this doesn't work:
 - (1) Check for no cold water supply or a kinked cold water hose.
 - (2) Check for a clogged inlet screen.
 - (3) Check for a defective cold water solenoid in the mixing valve.
 - (4) Check for a defective timer.

Note: The contacts for the spray rinse action are usually separate from the other contacts in a timer, and although the spray rinse does not work, the washer may work well except for that feature.

11. Troubleshooting a washer when water will not shut off

- a. On time-fill washers, the failure of water to shut off may indicate a timer malfunction.

Note: A time-fill machine is one where water fill volume is controlled by setting the timer for the washer to fill for a given period of time.

- b. Check the water level/water pressure switch and replace it if it is defective.
- c. Check for foreign particles in the mixing valve, and if that is suspected, take the valve apart and remove them.

Note: Cleaning a mixing valve can be accomplished in the field, but if it does not correct the problem, the valve should be replaced.

- d. On pressure-filled models check for a break or pinhole in the air chamber or connecting tubing, and replace either or both as required.

Note: If water gets in the air chamber or pressure tube, it will have the same effect as a pinhole, and this sometimes happens when a washer is tilted for cleaning or for moving.

12. Troubleshooting a washer that leaks water

- a. Check for loose or cracked supply hoses and tighten or replace as required.
- b. Check for a loose drain hose and tighten or replace the clamp as required.
- c. Run the washer through a normal cycle and replace any hose that is broken or appears to be damaged.
- d. Check for worn or damaged supply hose washers.
- e. Check for leaky gaskets:
 - (1) around the water pump,
 - (2) where the transmission enters the outer tub,
 - (3) seals between the inner and outer tub, and
 - (4) outer tub gasket.
- f. Check for cracked housing at:
 - (1) outer tub, especially tubs made of plastic,
 - (2) water pump housing, and
 - (3) mixing valve housing.
- g. Replace any component with cracked housing.

13. Troubleshooting when water will not drain from a washer

- a. Check for a kinked or clogged drain hose and correct as required.
- b. Check for a water pump problem, and readjust the pump and tighten the pump drive.

Note: On models with a drain-before-spin feature, suds lock sometimes occurs, but this can usually be corrected by dumping cold water into the tub to break up the suds.
- c. Check for a loose belt at the water pump and adjust as required.
- d. Check for a faulty transfer or solenoid valve and replace as required.
- e. Check for a defective water pump and replace as required.
- f. Check for a faulty timer and replace as required.

14. Troubleshooting a washer with a motor that will not run

- a. ~~Make~~ Make sure there is power to the machine.
- b. Check for a faulty door/lid switch and replace as required.
- c. Check for an overload device or other protective device in the circuit and replace as required.
- d. Check for a faulty timer and replace as required.
- e. Check for a faulty motor and replace as required.

15. Troubleshooting a washer that will not agitate

- a. Check for a motor malfunction and replace as required.
- b. Check timer for bad contacts and correct or replace as required.
- c. Check for a faulty transmission and repair or replace as required.
- d. Check for broken linkage or other agitation control mechanism.

Examples: The agitate drive roller on a Frigidaire, the agitate solenoid on the Kenmore, and the eccentric linkage connection of the Speed Queen are potential trouble spots.

- e. Check for a broken wire in circuitry and splice, tin, and insulate as required.
- f. Check for stripped splines in the agitator.

16. Troubleshooting a washer that will not spin

- a. If the washer will agitate but not spin, the motor is probably okay.
- b. Check timer for defective contacts and replace as required.
- c. Check the door or lid switch and replace as required.
- d. Check for a faulty transmission and repair or replace as required.
- e. Check for broken linkage or other spin control mechanisms.

Examples: The spin roller on a Frigidaire, the spin control solenoid on a Kenmore, and the fluid drive unit on a Speed Queen are spin control mechanisms.

- f. Check for a faulty water level switch and replace as required.
- g. Check for a broken wire in circuitry and splice, tin, and insulate as required.

17. Troubleshooting a washer that will not advance or shut off

- a. If the timer will not advance, check the timer contacts.
- b. Check for a defective timer and replace the timer if required or replace the timer motor if that is the problem.
- c. Replace a timer motor only with the exact type of motor removed or the timed cycles will all be wrong.
- d. Check for a break in the circuitry wiring and splice, tin, and insulate as required.

18. Troubleshooting a washer that leaks oil

- a. If oil leaks on the floor, check for a leak in the gearcase caused by a faulty gasket, damage to the gearcase housing, or a bad transmission seal.
- b. If oil leaks onto clothes in the tub, check for a faulty gearcase or transmission seal and replace seal or transmission as required.

Note: On Norge and GE washers, it is recommended that the transmission be replaced, but on Kenmore/Whirlpool washers, both the tub and transmission seals can be replaced.

19. Troubleshooting a washer that tears clothing

- a. Caution the user to use bleach wisely:
 - (1) do not use too much bleach.
 - (2) do not add bleach at the wrong time.
 - (3) add bleach to water before loading clothes in the tub, or dilute bleach with water before putting it in the tub.
- b. Check for a broken agitator and replace if required because chips and cracks in the agitator can tear clothes.
- c. Check for a defective inner tub or basket and replace as required.

20. Other washer problems and ways to correct them

- a. **Machine spins slowly**—Adjust belt to clutch or replace clutch if it is faulty
- b. **Water does not recirculate during agitation**—Clean out clogged water pump
- c. **Defective pump drive**—Tighten as needed or replace the coupling
- d. **Defective distribution valve**—Clean out or replace valve, or replace solenoid as required

Information Sheet

- e. **Timer will not advance to next cycle**—Replace timer motor, or replace entire timer as required
- f. **Frozen timer shaft or knob**—Check for obstructions and free the shaft or replace the timer as required
- g. **Faulty water level switch**—Replace the control
- h. **Washer vibrates excessively**—Reinforce weak floor or move washer, check for level, caution user not to overload or create unbalanced loads, or replace rubber cups on leveling feet
- i. **Tub vibrates excessively**—Check for a damaged snubber and replace as required, or adjust or replace suspension bolts

Note: Vibration may indicate a faulty transmission or worn bearings.

Automatic Washers
Unit 7

MAR-219

Job Sheet 1—Install an Automatic Washer

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Installation area inspected and acceptable	_____
Customer/installation literature saved for reference	_____
Electrical connections/grounding correctly completed	_____
Washer operated to verify correct installation	_____
Customer instructed about operation and maintenance	_____

A. Tools and materials

Washer as selected by instructor
Standard hand tools and tool box
VOM
Level
Dolly
Safety glasses

B. Procedure

- ☐ 1. Put on safety glasses.
- ☐ 2. Uncrate The washer carefully.
- ☐ 3. Visually inspect the washer to make sure it is not damaged.
- ☐ 4. Secure washer on a proper dolly if it must be moved any distance to the installation site.
- ☐ 5. Inspect the location where the washer will be installed for:
 - (a) level, sturdy floor,

Note: If the floor is not level and sturdy, point out to the customer that the condition could impair performance and eventually damage the washer; if the customer insists the floor remain as it is, have the customer sign a release.

Job Sheet 1

- (b) adequate supplies of hot and cold water,
 - (c) adequate drainage, and
 - (d) adequate clearance and ventilation.
- ☐ 6. Remove ties, blocks, tape, and any other retaining devices installed to protect the washer during shipment.
 - ☐ 7. Check inside the washer for the owner's manual, installation kit, or any other materials that should be removed and saved.
 - ☐ 8. Set the washer in place.
 - ☐ 9. Connect hot and cold water hoses.
 - ☐ 10. Install grounding kit.

Note: Grounding kit installation varies from washer to washer, but the instructions should be with the washer and they should be carefully followed.

- ☐ 11. Level the machine side to side and front to back.
- ☐ 12. Check the receptacle for proper voltage.
- ☐ 13. Plug the washer power cord into a three-hole grounded receptacle only.

Caution: Never use an adapter or an extension cord that defeats the ground connection on a washer power receptacle because it will void the warranty and damage the washer.

- ☐ 14. Operate the machine through one normal cycle.

Note: Do not manually advance the timer; permit the washer to complete a full cycle on its own.

- ☐ 15. Explain operating procedure to the customer, and encourage the customer to follow recommended procedures for washer care and preventive maintenance.
- ☐ 16. Check the installation order and make sure you have recorded all serial numbers and any other information required to assure a correct warranty.
- ☐ 17. Clean up the installation area and make sure all crating materials or blocks and ties are removed from the customer's home.
- ☐ 18. Remind the customer that your company should be called for any questions about the washer or its performance.
- ☐ 19. Compliment the customer on making a wise decision in washer selection, and leave the customer on a positive note.

Job Sheet 1

MAR-221

- ☐ 20. Have your instructor check your work.
- ☐ 21. Return tools and materials to proper storage.

Comments: _____

**Automatic washers
Unit 7**

**Job Sheet 2—Troubleshoot a Whirlpool/Kenmore Automatic Washer
for Typical Malfunctions**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

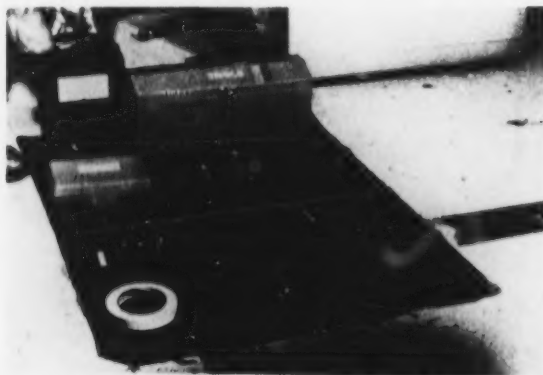
Evaluation Criteria	Rating
Control panel troubleshooting complete and correct	_____
Water level switch troubleshooting complete and correct	_____
Mixing valve troubleshooting complete and correct	_____
Water pump troubleshooting complete and correct	_____
Motor troubleshooting complete and correct	_____
Transmission tube troubleshooting complete and correct	_____
Clutch adjustment complete and correct	_____
Repair log complete with problems noted	_____

- A. Tools and materials
- Washer with service literature as selected by instructor
 - Standard hand tools and tool box
 - Motor test cord
 - Drop cord/inspection light
 - Drop cloth
 - VOM
 - Pressure bulb
 - Special Whirlpool/Kenmore tools
 - Spanner wrench #12393
 - Agitator drive block remover tool
 - Repair log (attached)
 - Safety glasses

Job Sheet 2

B. Routine 1—Troubleshoot the control panel

- ☐ 1. Sign on the repair log that accompanies this job sheet and save the log for use in later job sheets, and be sure to put on safety glasses.
- ☐ 2. Place drop cloth down, set the tool box on it, and generally prepare a safe uncluttered work area.



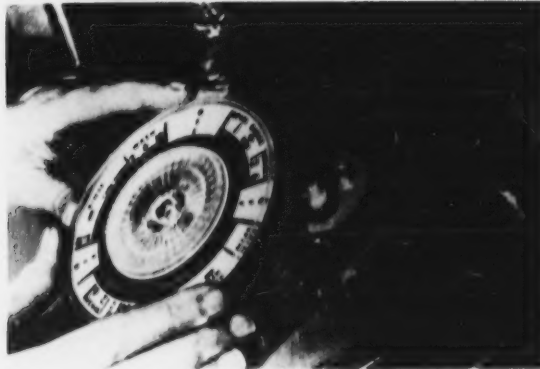
- ☐ 3. Unplug the washer.
- ☐ 4. Turn off water supply to hoses and disconnect fill hoses with channel-lock pliers.



- ☐ 5. Remove the timer knob by holding the timer dial and turning the knob in a counter clockwise direction.

Job Sheet 2

- ☐ 6. Remove the timer dial by first removing any retaining screws or lock nuts and lift slightly to remove the timer dial.



- ☐ 7. Remove the screws that retain the control panel (console).
- ☐ 8. Move the control panel forward far enough to expose all electrical connections.
- ☐ 9. Unplug the electrical connection to the control panel (it plugs into the machine) and remove the fill hose from the water pressure switch.



- ☐ 10. Place a drop cloth on top of the washer and set the control panel out on top of the lid for each access.

Job Sheet 2

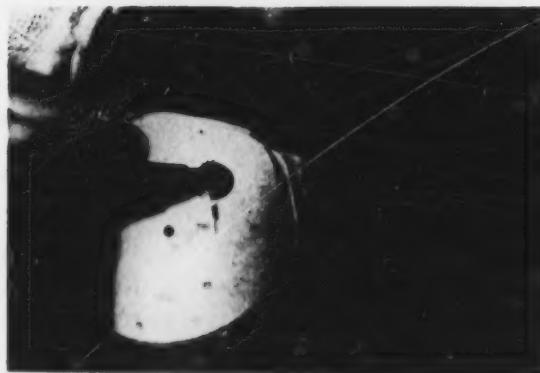
- 11. Disconnect the harness or individual leads to the timer and be sure to sketch or make notes of the location of each individual connector so you will know how to put them back.

Note: Failure to note the locations could cause you trouble later, and codes on schematics are not always reliable; even your knowledge of a particular appliance may not be counted on if you are dealing with a part some other technician has previously replaced.

- 12. Remove the inspection plate from the open-type timer and inspect the condition of the switch contacts.
- 13. Remove the timer motor and inspect the drive gear for frayed or worn spots that indicate wear.
- 14. Replace timer motor if wear is evident.
- 15. Test run the timer motor using a motor test cord:

- (a) scratch a mark at a point on the motor body and the gear to provide a reference point for checking timer motor rotation.

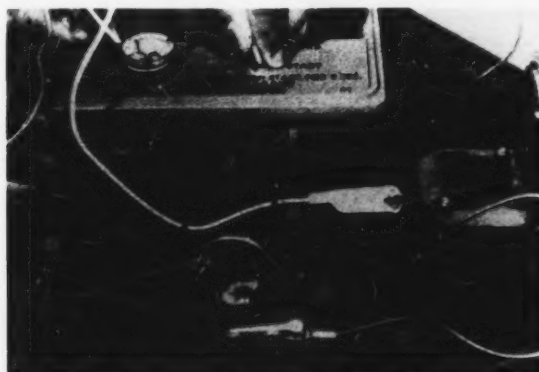
Caution: Be sure to make the mark clear because the motor advances so slowly that it cannot be seen by the naked eye.



- (b) connect motor test cord to timer motor (Robinaire Test Cord #12476). Use the black and white motor test leads.

Job Sheet 2

- (c) the test cord on to the RUN position and allow it to run for at least ten minutes.



- (d) if there is no noticeable timer motor advancement in a ten minute test period, the timer motor is defective and must be replaced.

- ☐ 16. Replace the old timer motor or install a new timer motor as test indicates.
- ☐ 17. Have your instructor check your timer removal.
- ☐ 18. Reinstall entire existing timer if it appears to be in good shape or replace the timer if it is obviously defective.

Note: Timer problems usually are obvious, but ask your instructor for help in your evaluation of the timer's condition.

- ☐ 19. Have your instructor check your timer installation.

Note: On a normal service call, the control panel would probably be reinstalled at this point, but leave it off for now.

- ☐ 20. Note on your repair log the length of time it took for you to accomplish Routine 1, and add five minutes to that figure to have a realistic assessment of the time it would have taken to remove, troubleshoot, and replace the timer.

C. Routine 2—Troubleshoot the water level switch

- ☐ 1. Sign on repair log and remove the knob from the water level switch.
- ☐ 2. Remove the retaining screw(s) that hold the switch.
- ☐ 3. Disconnect the individual leads to the water level switch and be sure to sketch the location of each individual lead so you can get each lead back in the proper location.

Job Sheet 2

- ☐ 4. Inspect the switch visually for any physical damage such as breaks or cracks in the housing or loose or corroded terminals.
- ☐ 5. Perform a continuity test on the water level switch contacts with the following procedure:
 - (a) sketch two pictorial diagrams of the three water level switch terminals and label the terminals V, P, or T to indicate they are violet, pink, or tan.
Example: 1. V P T
 2. V P T
 - (b) make the continuity test across the three switch terminals from V to T, from V to P, and from T to P.
 - (c) when the reading between any two terminals is zero ohms, connect those two terminals with a straight line (V____T) (V____P).
 - (d) when the reading between any two terminals is infinite ohms, which generally indicates an open circuit, leave the space between the terminals blank (T P).
- ☐ 6. Evaluate your first continuity test according to the following:
 - (a) if there is no line between the tan and violet terminals and there is a line between the violet and pink terminals, it indicates the switch is in the empty position and is probably okay.
 - (b) If the lines and open space are reversed, it indicates the switch is stuck in the full position and should be replaced.
- ☐ 7. Perform another continuity test on the water level switch with the following procedure:
 - (a) attach a pressure bulb to the water level switch at the opening to the diaphragm



Job Sheet 2

- (b) apply pressure to the bulb, listen for a clicking sound which indicates the diaphragm has moved to shift switch contacts, and at the same time take a continuity reading between terminals V and T.
 - (c) with no pressure, continuity between V and T should be infinite.
 - (d) when pressure is applied, continuity between V and T should be zero ohms.
 - (e) use your second diagram to indicate your final continuity reading.
 - (f) if there is an infinite reading between V and T with no pressure and a zero ohms reading between V and T when pressure is applied, the switch is shifting from the empty to the full position properly and should be a good switch.
- ☐ 8. Evaluate your continuity test and replace water level switch if required or put the old switch back in place.
 - ☐ 9. Replace the entire control panel.
 - ☐ 10. Note on your repair log the length of time it took to accomplish Routine 2.
 - ☐ 11. Have your instructor check your work.
 - ☐ 12. Clean up area and return tools and materials to proper storage or proceed to next routine as directed by your instructor.

D. Routine 3—Troubleshoot the mixing valve

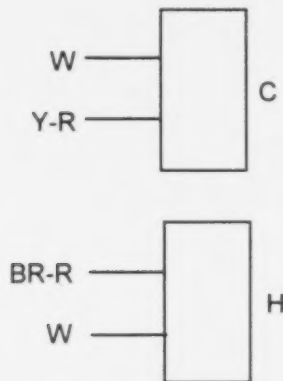
- ☐ 1. Sign on your repair log.
- ☐ 2. Raise the lid and secure it, and then locate the mixing valve.

Note: Refer to manufacturer's technical manual or ask your instructor if you have any questions about this procedure.

Job Sheet 2

- ☐ 3. Make a pictorial sketch of all conductors that lead to the mixing valve solenoids and note their identifying markings.

Note This is to avoid the prospects that the cold water conductors will not be hooked up to the hot water solenoid, or vice versa, when the mixing valve is reinstalled.



- ☐ 4. Remove the mixing valve.
- ☐ 5. Remove the solenoids from the mixing valve and make a continuity check with the following procedure:
- (a) check the cold water solenoid for continuity across the terminals and record the reading.
 - (b) check the hot water solenoid for continuity across the terminals and record the reading.
 - (c) if it is a three-solenoid valve, check the warm water solenoid for continuity across the terminals and record the reading.
- Note: The continuity reading should indicate a resistance reading of around 500-2000 ohms on the ohmmeter scale.
- ☐ 6. Conduct an electrical test on the solenoids with the following procedure:
- (a) you will need the Robinaire 1246 motor test cord and a paper clip.
 - (b) connect the motor test cord to the cold water solenoid (use the black and white leads on the test cord).
 - (c) turn the test cord to RUN and listen for a humming sound in the solenoid.

Job Sheet 2

- (d) place the paper clip near the solenoid opening and note whether or not the solenoid pulls the paper clip inside the solenoid.

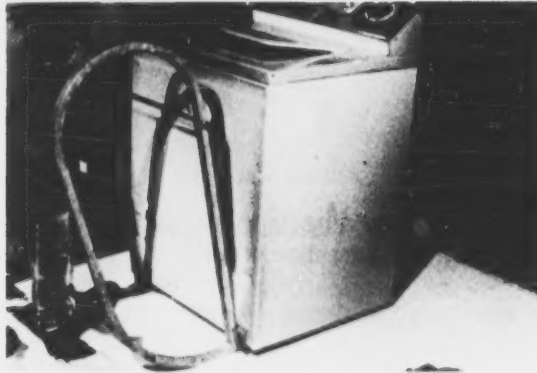


- (e) if the solenoid attracts the paper clip, it is probably good, and if there is no magnetic attraction present, the solenoid is probably defective.
- ☐ 7. Repeat the electrical test for the hot water solenoid and for the warm water solenoid, if there is one.
 - ☐ 8. Have your instructor check your work.
 - ☐ 9. Dismantle the mixing valve.
 - ☐ 10. Inspect the mixing valve diaphragm and other mixing valve parts and look for foreign particles and wear.
 - (a) if foreign particles are present, remove them.
 - (b) if valve parts evidence extensive wear, replace the mixing valve.
 - ☐ 11. Replace the mixing valve if the valve itself is worn or if any of the solenoids are defective because it is more cost-effective to replace than to repair.
 - ☐ 12. Put the valve back together and reinstall it or install a new mixing valve.
 - ☐ 13. Have your instructor check your work.
 - ☐ 14. Note on your repair log the length of time it took for you to accomplish Routine 3.

Job Sheet 2

E. Routine 4—Troubleshoot the water pump

- ☐ 1. Sign on your repair log.
- ☐ 2. Assemble special tools required for the routine:
- ☐ 3. Insert the flipper under the front of the machine and turn the machine over on its front so that the underside of the washer is readily accessible.



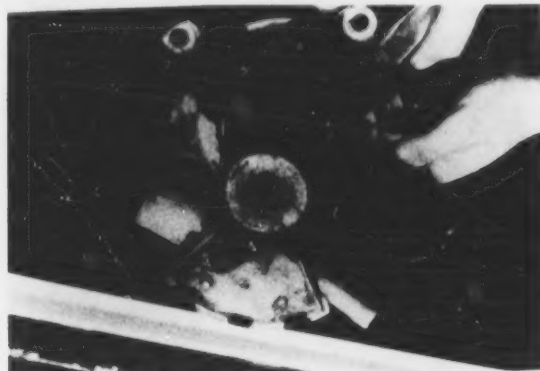
- ☐ 4. Place drop cloth down and arrange tool box to one side.
- ☐ 5. Use hose-clamp pliers to remove the hoses from the water pump and note their locations so you will get them back in the right place.
- ☐ 6. Loosen motor mounting bolts enough to provide enough slack in the drive belt that the belt can be removed.
- ☐ 7. Remove the two water pump retaining bolts.
- ☐ 8. Slip the pump away from the bolt and out of the washer.
- ☐ 9. Clean the pump as required and then inspect it for obstructions, and make sure it turns freely.

Job Sheet 2

- ☐ 10. Dismantle the pump and clean the impeller if it is a two-piece pump connected with retaining clips or screws.



- ☐ 11. Put pump back together.
- ☐ 12. Shift the directional level on the pump to make sure the direction control baffle inside the pump moves back and forth.



- ☐ 13. Reinstall the old pump if it is okay, or install a replacement pump if required.
- ☐ 14. Have your instructor check your work.
- ☐ 15. Note on your repair log the length of time it took for you to accomplish Routine 4.

Job Sheet 2

F. Routine 5—Troubleshoot the motor

- ☐ 1. Sign on your repair log.
- ☐ 2. Disconnect all electrical conductors to the motor and note where they go and their identifying colors and markings:
 - (a) single-speed motors should have two conductors, one blue and one white,
 - (b) two-speed motors should have three conductors, one blue, one orange, and one white,
 - (c) three-speed motors should have four conductors, one blue, one orange, one gray/pink, and one white.
- ☐ 3. Remove the two motor retaining bolts.
- ☐ 4. Remove the motor and place it on the drop cloth.
- ☐ 5. Conduct a continuity test on the motor with the following procedure:
 - (a) sketch two pictorial diagrams of the motor switch terminals and their identifying markings.



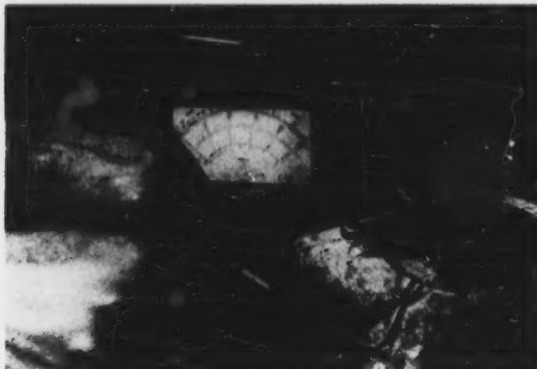
- (b) make a continuity check on the motor control terminals.
- (c) write meter readings on the first diagram, and this will probably be a reading of less than two ohms.

Note: If the motor is equipped with a capacitor, discharge the capacitor with a 2,000 ohm 2-watt resistor and short capacitor leads together.

- (d) record the resistance across the terminals.

Job Sheet 2

- (e) using a pencil or some other wooden object, depress the centrifugal mechanism.
- (f) record the resistance across the terminal with the centrifugal mechanism depressed.



□ 6. Evaluate your continuity check according to the following:

- (a) on a single speed (two terminal) motor, two things should happen:
 - 1) the first resistance reading should be a relatively low reading, approximately 2 ohms or less.
 - 2) the second reading with the centrifugal mechanism depressed should increase slightly to about 2 ohms.

- (b) If the first reading was a resistance of 2 ohms or more, the starting switch is defective, and depending on the application, replace the switch or the entire motor.

Note: On the throw-away motor, the starting switch can be replaced, and on the conventional motor it is not cost-effective to attempt internal motor repair.

- (c) if a resistance reading of zero ohms, infinite continuity, or a high resistance greater than 3 ohms comes up in your continuity check, either the starting switch or the motor itself is defective and should be repaired or replaced as previously indicated.

Note: For directions on continuity checks for two and three-speed motors, check the manufacturer's service material.

□ 7. Conduct continuity check and evaluations for two-speed and three-speed motors with the same general procedure outlined for single-speed motors.

Job Sheet 2

- ☐ 8. Test run the motor using a test cord with the following procedure:

(a) connect the test cord to the motor.

Note: This procedure is for a single-speed motor only; check service manual for two- or three-speed motor procedures.

(b) use the black and white leads from the test cord and connect the black lead to the blue motor terminal and the white lead to the white motor terminal.

(c) turn motor test switch to RUN.



(d) if the motor starts and runs, it is okay.

(e) if the motor does not start, or starts and runs erratically, the motor is defective and should be replaced.

Note: A current or amperage check should be made on the motor, but it can only be made with the motor under a real or simulated load.

- ☐ 9. Reinstall the motor and adjust the drive belt, but do not reconnect motor conductors yet.
- ☐ 10. Turn the appliance flipper so that the washer is upright again.
- ☐ 11. Connect the motor test cord to the motor as previously outlined.
- ☐ 12. Connect a clamparound ammeter to the white motor test lead.
- ☐ 13. Set the ammeter on high scale and turn test cord to RUN.

Job Sheet 2

- ☐ 14. Check amperage reading and compare your reading with the amperage specified on the motor identification plate.

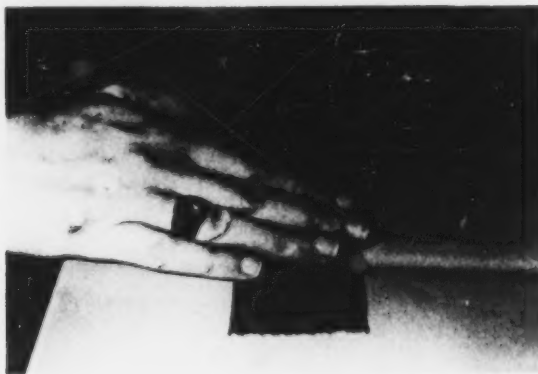
Note: The amount of current actually drawn by the motor under load should never be equal to or more than the full load amperage listed on the motor identification plate because the FLA reflects maximum capability and a washer motor should never function to its maximum potential.

- ☐ 15. Have your instructor check your amperage reading.
- ☐ 16. Replace the motor if amperage check indicates it is bad, but otherwise, make conductor connections and replace the old motor if all checks indicate it is probably okay.
- ☐ 17. Note on your repair log the length of time it took for you to accomplish Routine 5.

G. Routine 6—Troubleshoot the transmission/spin tube assembly

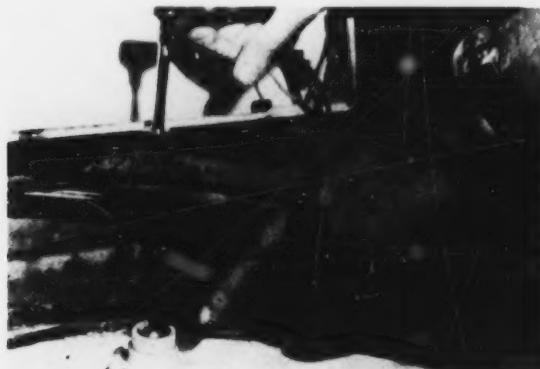
- ☐ 1. Sign on your repair log.
- ☐ 2. Raise the top according to directions in the service manual.

Note: On some models this may mean removing the recirculating hose first, but other models simply raise up; in all cases, it is a good idea to tape the lid down before moving the top.



Job Sheet 2

- ☐ 3. Remove the snubber by lifting up on the snubber retaining spring and lifting the snubber out of its spring support.



- ☐ 4. Remove the snubber retaining spring by removing the retaining nut and pulling the spring toward the front of the washer while pushing down on the back of the spring.
- ☐ 5. Remove the water inlet from the tub ring.

Note: On some models the inlet snaps in and out, and on other models it is held by a retaining screw that has to be removed.



- ☐ 6. Remove the tub ring and gasket with the following procedure.
 - (a) remove the clips or fasteners that hold the tub ring and be sure to note colors and sizes of clips by location.
 - (b) lift up on the tub ring to remove it.

- (c) remove the tub ring gasket.



- 7. Remove the agitator.

Note: Check the service manual for the procedure because agitator removal varies significantly from model to model.

- 8. Remove the agitator drive block (if there is one) with the following procedure:

- (a) insert the forks of a tie rod separator tool between the agitator drive block and the spin drive block.
- (b) drive the tool forward with a ball peen hammer and pry upward to remove the agitator drive block.

Note: If there is a stud that still retains the agitator drive block, it has to be removed before the block can be removed.

- 9. Remove the spanner lock nut with the following procedure:

- (a) place the spanner wrench over the nut so that it catches the grooves in the nut.

Job Sheet 2

- (b) tap the spanner wrench with a ball peen hammer in a counterclockwise direction to loosen it.



- (c) remove the spanner nut.

- ☐ 10. Remove the inner tub by lifting it up and out.



- ☐ 11. Remove the basket drive block.

Note: The basket drive block may have come out with the basket, and if so, just take the wooden end of your hammer and push the drive block out.



Job Sheet 2

- ☐ 12. Insert the flipper under the front of the machine and flip it over once again.
- ☐ 13. Remove all hoses from the water pump and get them out of the way.
- ☐ 14. Remove the water pump as previously outlined.
- ☐ 15. Remove all retaining or support braces (there may be as many as three) from the transmission and spin tube assembly/basket drive assembly.



- ☐ 16. Disconnect all electrical conductors from the spin/agitate solenoids mounted on the transmission and be sure to note the identifying colors and locations.
- ☐ 17. Remove the three transmission mounting bolts.

Note: The transmission bolt mounted on the underside has a spacer between the transmission and the frame, so be sure to keep track of the spacer for proper reinstallation.



- ☐ 18. Remove the belt from motor drive pulley.

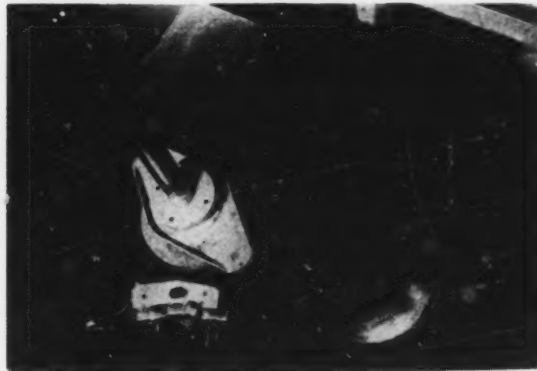
Job Sheet 2

- 19. Remove transmission and spin tube assembly by pulling on the spin tube assembly, not the transmission, so that the two will come out together.

Note: Pulling on the spin tube helps prevent damage to the retainer and spring at the top of the spin tube assembly, but do not lift the transmission from the agitator shaft because it will dislodge the thrust washer under the shaft.



- 20. Remove spin tube assembly from transmission with the following procedure:
- (a) remove the spring and retaining clip that hold the top of the spin tube assembly.
 - (b) lift the spin tube assembly up and off and inspect it.



- (c) look for worn areas on the brake and on the clutch pad, and also broken or missing springs.
- (d) check your service manual to see what components in the spin tube assembly can be replaced in the field.

Note: Generally, if any components in the spin tube assembly are damaged, it is more cost-effective to replace the entire spin tube assembly.

Job Sheet 2

- ☐ 21. Remove the thrust bearing (called a T-bearing) by slipping it off the agitator shaft.

Caution: Some models have ball bearings, and they are easy to lose if you are not careful.

- ☐ 22. Inspect the T-bearing for frayed or broken edges, and if it is a plastic bearing, it may have swelled from excessive wear.
- ☐ 23. Replace the T-bearing as required.
- ☐ 24. Check the agitate/spin solenoids with the following procedure:
 - (a) remove the solenoid mounting screw, and lift the solenoid out.



- (b) conduct a continuity test on the agitate solenoid and record the resistance reading.
 - (c) conduct a continuity test on the spin solenoid and record the resistance reading.

Note: Refer to the procedure outlined for checking the mixer valve solenoids if you have questions about this procedure.

- (d) the resistance reading should be 200-700 ohms in each solenoid to indicate that the solenoid is working okay.
- ☐ 25. Conduct an electrical test on the agitate/spin solenoids with the same procedure outlined for the electrical tests for the mixer valve outlined in Routine 3.
- ☐ 26. Replace the agitate/spin solenoids if they are defective, or reinstall them if they appear to be okay.

Job Sheet 2

- ☐ 27. Inspect the transmission with the following procedure:
- (a) check the spin cam bar to make sure it is not warped or that it has damaged edges.
 - (b) check the agitator cam bar to make sure it is not warped or that it has damaged edges.
 - (c) check the agitate and spin drive plungers to make sure the hardened pin is in good shape and that the plunger itself has no rough edges.

Note: Work the plungers up and down so you can make a good evaluation.
 - (d) check the operation of the transmission by manually shifting it from agitate to spin and rotating the drive pulley.
 - (e) If no damage or wear is noted, reassemble the transmission.

Note: Should there be evidence that the transmission required internal repair, check your service manual for procedure, and continue with transmission repair or replace the transmission as directed by your instructor.
- ☐ 28. Replace the transmission and spin tube assembly by reversing the disassembly procedure.

Note: Be sure to replace solenoid wiring through the hole in the control magnet assembly.
- ☐ 29. Have your instructor check your work.
- ☐ 30. Reinstall all hoses.
- ☐ 31. Make all necessary electrical and water connections.
- ☐ 32. Level the machine.
- ☐ 33. Plug washer in and run it through a normal cycle to check it:
- (a) if the washer will not pull a fairly heavy load, go on to Routine 7 and adjust the clutch.
 - (b) if you can keep the agitator from moving back and forth by holding it with your hand, that means the clutch needs adjustment and you should go on to Routine 7.
- ☐ 34. Note on your repair log the length of time it took you to complete Routine 6.

Job Sheet 2

- ☐ 35. Have your instructor check your work.

H. Routine 7—Adjust the clutch

- ☐ 1. Sign on your repair log.
- ☐ 2. Make tests as outlined in Routine 6 to confirm that the clutch needs adjusting.
- ☐ 3. Position yourself so you can reach the adjustment nut at the top of the basket clutch shaft.



- ☐ 4. Put a $\frac{3}{4}$ " open-end wrench on the nut and move the adjustment nut according to the following:
- (a) if the agitator has no torque, run the adjustment nut down about $\frac{1}{8}$ th of a turn.
- (b) if the agitator has too much torque, run the adjustment nut up about $\frac{1}{8}$ th of a turn.
- ☐ 5. Place the machine level and run a test load to check for proper torque and good agitation.
- ☐ 6. Drain the washer, unplug it from its power source, and make further adjustments as required.
- ☐ 7. Have your instructor check your work.
- ☐ 8. Sign off your repair log and be sure to note any special problems you have had with any of the routines in this job sheet.
- ☐ 9. Clean up area and return tools and equipment to proper storage.

Comments: _____

**Automatic Washers
Unit 7****Job Sheet 2****Repair Log**

Your name _____ Date _____

	Date	Time On	Time Off
Routine 1—Troubleshoot the control panel			
Routine 2—Troubleshoot the water level switch			
Routine 3—Troubleshoot the mixing valve			
Routine 4—Troubleshoot the water pump			
Routine 5—Troubleshoot the motor			
Routine 6—Troubleshoot the transmission/spin tube assembly			
Routine 7—Adjust the clutch			

Note any special problems you encountered in any of your troubleshooting routines:

Automatic Washers
Unit 7

MAR-249

Job Sheet 3—Troubleshoot a GE/Hotpoint Automatic Washer
for Typical Malfunctions

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Correct troubleshooting for washer that will not pump out	_____
Correct troubleshooting for timer problems	_____
Correct troubleshooting for water pressure switch problems	_____
Correct troubleshooting for water fill valves	_____
Correct troubleshooting for water pump problems	_____
Repair log complete with problems noted	_____

A. Tools and materials

Washer with service literature as selected by instructor
Standard hand tools and tool box
Motor test cord
Drop cord/inspection light
Drop cloth
VOM
Pressure bulb
Special Whirlpool/Kenmore tools
Spanner wrench #12393
Agitator drive block remover tool
Repair log (attached)
Safety glasses

B. Routine 1—Troubleshoot a washer that will not pump out

- ☐ 1. Sign on your repair log and put on safety glasses.
- ☐ 2. Verify the complaint by attempting to run the washer through a normal cycle:
 - (a) if the washer goes through a complete cycle but will not pull a load, or if agitate action is sluggish, the timer is probably okay and the trouble is probably in the brake and clutch assembly.

Job Sheet 3

- (b) if the timer will not advance, or if other functions will not work automatically, the timer or parts of the timer are bad and will have to be repaired.

Note: A distinctive feature of the GE/Hotpoint washer is that the timer does not have to be replaced as a unit; it can be repaired.

- (c) if the complaint indicates problems with the clutch and brake assembly, continue with Routine 1, and if it is a timer problem, go on to Routine 2.

- ☐ 3. Drain the washer and unplug it from its power source.
- ☐ 4. Strap the washer to an appliance flipper and turn it over on its face or turn the washer over onto a blanket or comforter.
- ☐ 5. Disconnect the web coupling between the pump and the clutch drive assembly, and be sure to save the clamp.



- ☐ 6. Mark the leads to the motor terminals so you will know how to put them back, and then remove the leads to the motor.

Note: Some units will have a plug that is easy to unsnap.

- ☐ 7. Remove the motor and clutch/brake assembly as a unit, and place it on a workbench.

- ☐ 8. Use a ball peen hammer and a punch to remove the dowel pin at the bottom of the web coupling.



- ☐ 9. Put nails or pieces of wire through the small holes of the slip shoes where the shoes extend through the outer drum assembly.



- ☐ 10. Remove the outer drum assembly.
- ☐ 11. Inspect the primary shoes and the inner lock-in and outer lock-in shoes for glazing or excessive wear, and continue with disassembly as required to remove worn brake shoes.

Job Sheet 3

- ☐ 12. Remove the U-bolt and plate clamp from the shaft extension assembly.



- ☐ 13. Remove the washer, clutch leaf spring, and the primary shoe assembly and be sure to keep everything in order so you can reassemble everything properly.
- ☐ 14. Remove the shaft extension assembly from the motor shaft; this may require using some spray lubricant and working the assembly back and forth, or even using a small pry bar.



Job Sheet 3

- ☐ 15. Remove the outer and inner lock-in shoes, and be sure to keep all washers and springs in order.



- ☐ 16. Replace the outer and inner lock-in shoes as required, and be sure to get all springs and washers in their proper places.
- ☐ 17. Replace the shaft extension assembly and secure the U-bolt and plate clamp in place on the motor shaft.
- ☐ 18. Replace the primary shoes as required, and be sure to get all washers and springs back in their correct places.
- ☐ 19. Inspect the inner surfaces of the slip shoes for excessive wear and glazing, and replace as required.
- ☐ 20. Replace the clutch leaf spring and washer over the primary shoe assembly.
- ☐ 21. Replace the outer drum assembly.
- ☐ 22. Replace the retaining rings and bearings in proper order.
- ☐ 23. Replace the lower drive plate and drive the dowel pin back into place with a punch and a ball peen hammer.
- ☐ 24. Have your instructor check your work.
- ☐ 25. Fit the motor and clutch/brake assembly back into place, and secure the motor loosely to its mountings.
- ☐ 26. Attach the drive belt by moving the motor out until the belt has a deflection equal to the width of the belt when a moderate amount of pressure is applied, and then tighten the motor in place.

Job Sheet 3

- ☐ 27. Reattach the web coupling to the lower drive with the clamp that was previously removed.
- ☐ 28. Place washer upright and check all hoses.
- ☐ 29. Plug washer into properly grounded power supply.
- ☐ 30. Run the washer through a complete cycle and check for proper operation.
- ☐ 31. Have your instructor check your work and sign off repair log.

C. Routine 2—Troubleshooting the timer

- ☐ 1. Sign on your repair log.
- ☐ 2. Unplug the washer from its power source.
- ☐ 3. Remove the screws on each end of the console and turn the console over onto the lid so you can conveniently get to the timer and to the service information stored inside the console.



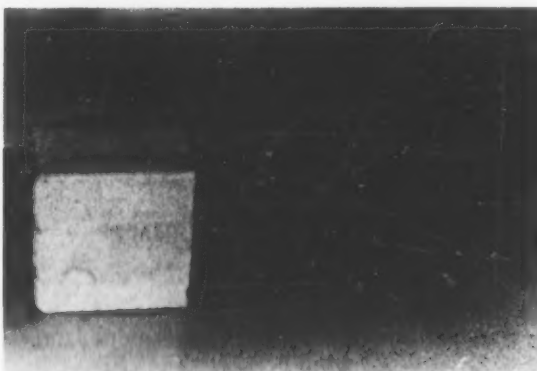
- ☐ 4. Start your troubleshooting based on the complaint that the washer will not fill, and since this involves checking the timer cams that control the fill functions, you will have to remove the timer:
 - (a) if there is a timer schematic attached to the back of the console panel, look it over to make sure you understand how to replace all leads or plugs before you remove them.

Job Sheet 3

- (b) if there is no schematic attached, sketch the wiring harness, and label the color codes for every terminal.



- ☐ 5. Remove the four Phillips screws that hold the top half of the timer in place, but hold the timer in place with your other hand as you take the screws out.
- ☐ 6. Remove the top half of the timer, making sure that any springs or small gears that are part of the assembly.
- ☐ 7. Make sure the metal inserts in the cam follower stay in place, and if the dowel-like inserts should come out of the cam follower, check the service information for proper replacement.
- ☐ 8. Take the top half of the timer to a workbench, turn it over carefully, and set it down in a clean work space.
- ☐ 9. Inspect all contacts on the timer switches for evidence of discoloration which indicates burned contacts, or for spots where contacts obviously burned.



Job Sheet 3

- ☐ 10. Replace switch assemblies as required according to the following:
 - (a) the switch assembly with 2 terminals is part #WH12X94.
 - (b) the switch assembly with 3 terminals is part #WH12X195, or it may be the 3 terminal switch used with the long silver plunger, and that is part #WH12X395.
 - (c) the switch assembly with 4 terminals is part #WH12X410.
 - (d) the switch assembly with 5 terminals is part #WH12X97.

Note: If you have any doubts about which switch to use, check the service information and the inserts in the cam follower.
- ☐ 11. Use a 1/4" nut driver to remove the old switches and to tighten the new switches in place, but do not overtighten the studs or you will break the plastic housing.
- ☐ 12. Double-check the inserts in the cam follower to make sure they are in the proper places, and then reassemble the timer.
- ☐ 13. Replace the timer in the console, and put the four Phillips screws back in place.
- ☐ 14. Put all the leads back in place on the proper timer switch terminals.
- ☐ 15. Have your instructor check your work.
- ☐ 16. Put the console back in place and secure it.
- ☐ 17. Plug the washer into a properly grounded receptacle and run it through a complete cycle:
 - (a) if the washer goes through the cycle properly, the new switch or switches have corrected the problem.
 - (b) if the washer does not fill properly, go on to the next routine for checking the water pressure switch.
- ☐ 18. Have your instructor check your work and sign off repair log.

Job Sheet 3

D. Routine 3—Check the water pressure switch

- ☐ 1. Sign on your repair log.
- ☐ 2. Unplug the washer from its power source.
- ☐ 3. Remove the screws that hold the console in place, and turn the console over onto the washer lid.
- ☐ 4. Disconnect the three leads to the pressure switch.



- ☐ 5. Set your VOM to measure ohms on the R x 1 scale.
- ☐ 6. Remove the air hose from the pressure switch and visually inspect it to make sure it is not damaged.
- ☐ 7. Find another piece of hose the same size as the pressure switch hose and install it onto the pressure switch with one end clear so you can blow through it.
- ☐ 8. Set your VOM to measure ohms on the R x 1 scale.
- ☐ 9. Place one VOM lead on the violet terminal and the other VOM lead on the purple or red terminal.
- ☐ 10. Verify that there is a full scale deflection on the VOM, which will indicate little or no resistance.
- ☐ 11. Leave the first lead on the violet terminal, remove the second lead from the purple or red terminal, and place it on the tan terminal.

Job Sheet 3

- ☐ 12. Verify that there is no reading on the VOM.
- ☐ 13. Blow into the tube, listen for a clicking sound, and verify a full scale deflection on the VOM to verify that the pressure switch is okay.



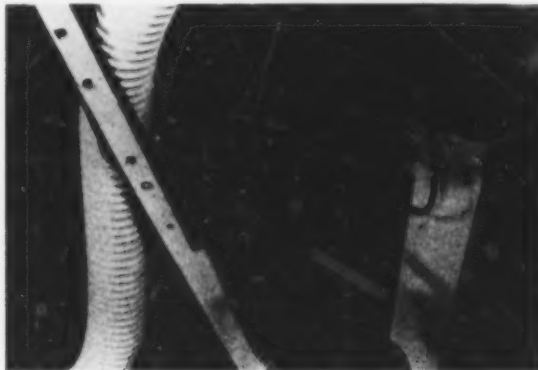
- ☐ 14. Have your instructor check your work.
- ☐ 15. Inspect all wires and terminals associated with the pressure switch, and repair or replace as needed.
- ☐ 16. Have your instructor check your work.
- ☐ 17. Replace the leads to the pressure switch, the pressure switch hose, and then replace the console.
- ☐ 18. Plug the washer into a grounded receptacle and run it through a complete cycle:
 - (a) if the washer fills properly, you have solved the problem.
 - (b) if the washer still has fill problems, go on to the next routine.
- ☐ 19. Have your instructor check your work and sign off your repair log.

E. Routine 4—Check the water fill valves

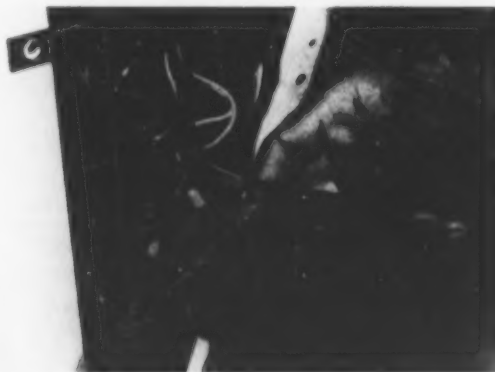
- ☐ 1. Sign on your repair log.
- ☐ 2. Unplug the washer from its power source.
- ☐ 3. Turn off the hot and cold water supplies and remove the hoses from the washer.

Job Sheet 3

- ☐ 4. Remove the mounting screws that hold the water valve mounting bracket on the back of the washer.



- ☐ 5. Pull the water valve solenoids out so you can conveniently check them.
- ☐ 6. Make a sketch of the leads to the solenoids so you will get them back in the proper places, and then remove the leads.
- ☐ 7. Set your VOM to measure ohms on the R x 100 scale.
- ☐ 8. Place the VOM leads on the two terminals of one of the solenoids.



- ☐ 9. Look for a reading of approximately 525 ohms:
- (a) if the reading is too high, it means the solenoid should be replaced.
 - (b) if there is no reading, it means the solenoid has an opening and should be replaced.
- ☐ 10. Repeat the procedure for the other solenoid.

Job Sheet 3

- ☐ 11. Replace solenoids as required.
- ☐ 12. Have your instructor check your work.
- ☐ 13. Secure the solenoid support bracket.
- ☐ 14. Replace the hot and cold water hoses.
- ☐ 15. Turn on the hot and cold water supplies.
- ☐ 16. Plug the washer into a grounded receptacle and run it through a complete cycle.
- ☐ 17. Have your instructor check your work and sign off repair log.

F. Routine 5—Check the water pump

- ☐ 1. Sign on your repair log.

Note: Failure to pump out water is a common washer complaint, and it almost always means trouble with the water pump.

- ☐ 2. Unplug the washer from its power source and turn off and disconnect the hot and cold water supplies.
- ☐ 3. Secure the washer to an appliance flipper and turn it over on its front side.
- ☐ 4. Use snap-ring pliers to remove the clamps from the hoses on the pump, and then remove the hoses.
- ☐ 5. Inspect the two pump openings to make sure there are no small or delicate pieces of clothing clogging the openings.

Note: Since GE/Hotpoint washers have no holes in the tub except at the top of the rim, the washers have to spin water out over the top of the tub, and small or delicate articles of clothing sometimes get past the clothes guard and are drawn into the water pump.

Job Sheet 3

- ☐ 6. Remove the top half of the web coupling to free the water pump.
- ☐ 7. Remove the three screws holding the pump to the tub bracket.



- ☐ 8. Remove the pump, take it to a workbench, and remove the six screws that hold the pump together.
- ☐ 9. Scrape off detergent build-up inside the pump, and be careful not to damage the gasket.



Job Sheet 3

- ☐ 10. Inspect the impeller and pump valve for worn or broken vanes.
- ☐ 11. Replace broken or worn pump parts as they are available.

Note: Pump kits are available, but broken or worn parts usually mean the entire pump assembly has to be replaced.

- ☐ 12. Reassemble the pump.
- ☐ 13. Remount the pump on the tub bracket and replace the pump hoses.
- ☐ 14. Reconnect the web coupling.
- ☐ 15. Have your instructor check your work.
- ☐ 16. Set the washer upright, reconnect the hot and cold water hoses, and plug the washer into a grounded receptacle.
- ☐ 17. Run the washer through a complete cycle to verify that the pump is working properly.
- ☐ 18. Have your instructor check your work.
- ☐ 19. Sign off your repair and be sure to note any special problems you had with any of the routines in this job sheet.
- ☐ 20. Clean up area and return tools and materials to proper storage.

Comments: _____

**Automatic Washers
Unit 7****Job Sheet 3****Repair Log**

Your name _____ Date _____

	Date	Time On	Time Off
Routine 1—Troubleshoot a washer that will not pump out			
Routine 2—Troubleshoot the timer			
Routine 3—Troubleshoot the water pressure switch			
Routine 4—Troubleshoot the water fill valves			
Routine 5—Troubleshoot the water pump			

Note any special problems you encountered in any of your troubleshooting routines:

Automatic Washers Unit 7

Job Sheet 4—Troubleshoot a Microprocessor Control Panel for Typical Malfunctions

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Self-diagnostic tests completed per service manual	_____
Control panel removed and replaced, if required	_____
Touchpad checked for proper resistance readings	_____
Primary and secondary sides of transformer checked for resistance	_____
Transformer reinstalled or replaced as required	_____
Repair log complete with problems noted	_____

A. Tools and materials

Washer with service literature as selected by instructor
 Control panel service literature
 Standard hand tools and tool box
 VOM
 Repair log (attached)
 Safety glasses

B. Routine 1—Run self-diagnostic tests on a control panel

- ☐ 1. Sign on your repair log, and consult service literature for recommended troubleshooting routine.

Note: Some microprocessors have self-diagnostic capabilities. Consult service literature to determine if microprocessor board is capable of self-diagnostic tests. If board is capable of self-diagnostics, complete self-diagnostic procedure according to instructions in service literature.

Job Sheet 4

- ☐ 2. Troubleshoot board following procedures in service literature.
- ☐ 3. If self-diagnostics or troubleshooting procedure indicate board is normal, skip the remaining steps in this Routine and go on to Routine 2.
- ☐ 4. If self-diagnostics or troubleshooting indicate board is defective, continue routine to remove and replace board.
- ☐ 5. Put on safety glasses.
- ☐ 6. Disconnect washer power cord.
- ☐ 7. Locate the control panel and open for access according to instructions in service literature.
- ☐ 8. Remove control panel according to instructions in service literature.
- ☐ 9. Disconnect microprocessor board and remove according to instructions in service literature.
- ☐ 10. Install new microprocessor board and connect according to instructions in service literature.
- ☐ 11. Reinstall control panel according to instructions in service literature.
- ☐ 12. Plug in washer and check new control panel.
- ☐ 13. If self-diagnostics indicate that board is normal, sign off repair log and continue testing control panel according to procedure in Routine 2.

C. Routine 2—Check touchpad

- ☐ 1. Sign on your repair log and put on safety glasses.
- ☐ 2. Disconnect washer power cord.
- ☐ 3. Locate the control panel and open for access according to instructions in service literature.
- ☐ 4. Remove control panel according to instructions in service literature.
- ☐ 5. Disconnect microprocessor board and remove from control panel according to instructions in service literature.

Job Sheet 4

- ☐ 6. Using VOM check touchpad for correct resistance with pads pressed and open, according to instructions in service literature. Record the connections and your findings in the space below:

Note: The touchpad is connected to the microprocessor board by a ribbon connector that contains conductive strips. The number of strips and their contacts vary by make and model of washer. Consult appropriate service literature to determine proper contacts and resistance readings.

- ☐ 7. Reinstall or replace touchpad as required according to instructions in service literature and sign off repair log.

D. Routine 3—Check transformer

- ☐ 1. Sign on repair log and put on safety glasses.
- ☐ 2. Disconnect washer power cord.
- ☐ 3. Consult service literature for location of transformer.
- ☐ 4. Locate transformer and remove according to instructions in service literature.
- ☐ 5. Using VOM, check primary side of transformer for continuity and resistance as specified by service literature. Record your findings in the space below:

- ☐ 6. Using VOM, check secondary side of transformer for continuity and resistance as specified by service literature. Record your findings in the space below:

Job Sheet 4

- ☐ 7. Using VOM, check voltage on primary side of transformer as specified by service literature. Record your findings in the space below:

Caution: Live voltage checks require extreme caution. Always make certain that power cord to dryer is disconnected when you are connecting or disconnecting VOM leads.

- ☐ 8. Using VOM, check voltage on secondary side of transformer as specified by service literature. Record your findings in the space below:

- ☐ 9. Disconnect washer power cord.
- ☐ 10. Reinstall or replace transformer as required, according to instructions in service literature.
- ☐ 11. Have your instructor check your work.
- ☐ 12. Sign off your repair log and return tools and material to proper storage.

**Automatic Washers
Unit 7****Job Sheet 4****Repair Log**

Your name _____ Date _____

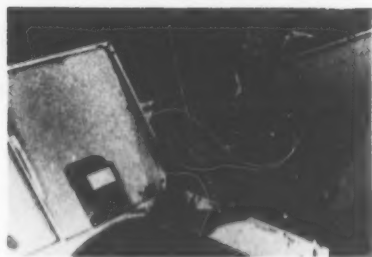
	Date	Time On	Time Off
Routine 1—Run self diagnostic			
Routine 2—Check touchpad			
Routine 3—Check transformer			

Note any special problems you encountered in any of your troubleshooting routines:

Automatic Dryers

Unit 8

Objective Sheet



Unit Objective

After completing this unit, the student should be able to install an automatic dryer, troubleshoot a Whirlpool/Kenmore automatic dryer for typical malfunctions, troubleshoot a GE/Hotpoint automatic dryer for typical malfunctions, and troubleshoot a microprocessor control panel for typical malfunctions.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to automatic dryers with their correct definitions.
2. Match major components with their functions in an automatic dryer.
3. Arrange in order the steps in automatic dryer operation.
4. Complete statements about thermostats and their functions in a dryer.
5. Complete statements about troubleshooting a dryer that will not run.
6. Select true statements about troubleshooting a dryer that will run but not heat.
7. Complete statements about troubleshooting a dryer when the motor runs but the drum will not rotate.
8. Complete statements about troubleshooting a dryer that runs but will not shut off.
9. Select true statements about troubleshooting a dryer that runs and heats but will not dry clothes.
10. Match other dryer problems with their solutions.
11. Complete statements about troubleshooting gas valves and igniters on gas dryers.
12. Match special gas dryer problems with their solutions.
13. Install an automatic dryer. (Job Sheet 1)
14. Troubleshoot a Whirlpool/Kenmore automatic dryer for typical malfunctions, (Job Sheet 2)

Objective Sheet

15. Troubleshoot a GE/Hotpoint automatic dryer for typical malfunctions, (Job Sheet 3)
16. Troubleshoot a microprocessor control board for typical malfunction. (Job Sheet 4)

Automatic Dryers
Unit 8

Information Sheet

1. Terms and definitions

- a. **Automatic Dryer**—An appliance designed to dry wet clothes in a heat, air flow sequence in a drum that tumbles clothes as it rotates under control of a timer
- b. **Centrifugal**—The force that impels something outward from a rotating center
- c. **Cycle**—One complete series of events that completes a procedure
- d. **Pilot burner**—A continuous small flame used in gas appliances to ignite the gas burner (also called a pilot light)
- e. **Purging**—Any procedure that cleans or removes obstructions such as removing air from a gas line

2. Major components and their functions in an automatic dryer

- a. **Timer**—The electromechanical brain of an automatic dryer that controls the sequence of functions
- b. **Motor**—Turns the drum, controls the heat circuit, and drives the blower
- c. **Heat source**—An electric dryer uses an electric heating element and a gas dryer uses a gas valve and burner assembly
- d. **Thermostats**—Devices that sense temperature and open or close to energize or de-energize the heat circuit

3. Steps in automatic dryer operation

- a. When the dryer starts, timer contacts energize the drive motor circuits.
- b. Through a series of motors or belts, the drive motor rotates the drum and causes clothes inside to tumble.
- c. As the drum rotates, air is circulated into the drum to provide proper heat.

Note: Some dryers have a fan to provide proper air flow.

- d. In a normal cycle, after the motor circuits are energized, another set of contacts in the timer energize the dryer heat circuit.

Information Sheet

- e. The drying cycle runs for a selected length of time and is controlled by the drive motor.

Note: Having the dryer heat circuit controlled by the drive motor starting switch is a safety feature that insures that air flow and drum rotation should start before the heat circuit is energized, and this prevents overheating on both gas and electric dryers.

- f. During the last five minutes, the starting switch circuit opens, heat stops and dissipates, and cooler air flows through the clothes as the tumbling action continues until the cycle is complete.

Note: Most models refer to this final part of the cycle as "cool down."

4. Thermostats and their functions in a dryer

- a. Cycling thermostats in a dryer help maintain a constant heat level inside the drum when clothes are tumbling.
- b. The safety or limiting thermostat shuts the dryer heat circuit off when there is evidence the dryer may overheat.
- c. Cycling thermostats are mounted in or on the air exhaust duct so they can sense both the temperature and moisture level of the air in the drum.
- d. As the temperature in the drum reaches the limits of a cycling thermostat setting, the thermostat de-energizes the heat circuit and will remain open until the air cools sufficiently, and then close to energize the circuit again.

Note: This may also complete a circuit to the timer.

- e. The number of cycling thermostats in a dryer may vary, but many have low heat, medium heat, and high heat thermostats to provide the user with temperatures for a variety of fabrics.

5. Troubleshooting a dryer that will not run

- a. Make sure the dryer is plugged into a proper power source, and then check the branch circuit control.
- b. Check for loose wires at terminals and run a continuity check on the circuitry to make sure there are not broken wires.
- c. Check for a faulty door switch by first making sure the door is properly shut and then running a continuity check on the door switch, and replace as required.
- d. Check motor wiring and motor centrifugal switch, and replace motor or switch as required.

- e. Check the timer and timer circuitry and replace the timer motor or the timer as required.

6. Troubleshooting a dryer that will run but not heat

- a. Check for loose wires on terminals and run a continuity check to make sure there are no broken wires.
- b. On an electric dryer, check for a proper 240V power supply.
- c. Check for defective thermostats and replace as required.
- d. Check for a wrong setting on the heat switch or check the heat switch itself and replace as required.

Note: This check applies only to dryer models with temperature selector switches.

- e. Check timer and timer wiring and replace timer motor or entire timer as required.
- f. Check the centrifugal switch, if it is the type of motor that has one, and replace as required.
- g. Check for an open heater element and replace heater element as required.
- h. On a gas model, check the gas supply and make sure the gas supply valve is open.
- i. If the gas model has a pilot light that is out, purge the line as indicated on the dryer plate directions and relight the pilot.
- j. Check for a defective solenoid coil in the gas valve by testing the coil for an open circuit, and replace the solenoid, if required, or the entire gas valve.

Note: On some models solenoids can be replaced, and the voltage reading at the valve should be indicated on the dryer plate, but this voltage is usually 120V.

- k. Check for a defective flame switch.
- l. Check for a malfunctioning igniter.

7. Troubleshooting a dryer when the motor runs but the drum will not rotate

- a. Check for a slipping or broken belt and adjust or replace as required.
- b. Check for a loose pulley and tighten the pulley on the motor shaft.
- c. Check for foreign objects that may be obstructing drum movement and remove them.

Information Sheet

- d. Check for a frozen bearing and replace as required.
- e. Check for tension and adjust or replace.

8. Troubleshooting a dryer that runs but will not shut off

- a. Check to see if one side of the branch circuit control is tripped open.

Note: When a circuit overload occurs and the motor side or L₁ side of the line control fuse or breaker trips open, the motor will continue to run through L₂ or in series with the motor heating circuit.

- b. Check for a defective timer and replace timer motor or timer as required.

9. Troubleshooting a dryer that runs and heats but will not dry clothes

- a. Check for a clogged lint screen and clean or replace as required.
- b. Check for a clogged exhaust vent.
- c. Check for incorrect heat or timer setting and reset as required.
- d. Check for a leaky door seal and if the door seal leaks air, replace it.
- e. Check for leaky drum seals and replace as required.
- f. Check for a fan or pulley loose on its shaft and tighten as required to restore good air motion in the drum.
- g. Check for defective operating thermostats, and if any of the thermostats are cycling too soon or too late, replace them.

Note: Checking thermostats requires using a temperature tester as outlined in Job Sheet 2.

- h. Find out if clothes were too wet when placed into the drum, and encourage customer to make sure clothes are properly wrung out before placing them in the dryer.

Note: Excessively wet clothes indicates the customer may also have a problem with an automatic washer, and a sharp repair technician will suggest that the washer may also need repair.

Information Sheet

10. Other dryer problems and their solutions

- a. Dryer repeatedly blows fuses or trips breaker:
 - (1) check wiring for bare spots that may be touching the frame.
 - (2) check for a sagging drum that may be causing the heater element to touch its housing.
 - (3) check heater element for foreign matter.
- b. Motor runs when door is open and timer fails to advance:
 - (1) check for a defective door switch and replace as required.
 - (2) check for a dial that binds because it is too far out from the control panel, and relocate the dial on the timer shaft to eliminate binding.
- c. Drum inspection light is burned out: replace the bulb.

Note: If the drum inspection light is burned out, always replace it because it is something a customer can immediately see and respond to positively.
- d. Dryer heats with door open or in OFF cycle:
 - (1) check centrifugal switch.
 - (2) check for malfunctioning heating element.

11. Troubleshooting gas valves and igniters on gas dryers

- a. Make sure gas is turned off.
- b. When a test shows that there is voltage to a gas valve but there is no flame, the problem is in the gas valve circuitry and the entire valve should be replaced.

Note: Some models have replaceable solenoids.
- c. The igniter is serviceable in the field, but a continuity test should indicate a resistance between 50 to 400 ohms, and if continuity is otherwise, the igniter also should be replaced.

Note: Dryers with manually-lit pilot lights are no longer manufactured.

Information Sheet

- d. When installing a gas dryer or when relighting one that has been repaired, purge the gas line with the following procedure:

- (1) turn the gas off,
- (2) loosen the connection between the shut-off valve and the burner, and
- (3) turn gas on until you hear or smell gas at the loose connection, turn the gas off, and tighten the connection.

Note: Purging clears air from the line and saves time relighting the pilot burner.

12. Special gas dryer problems and their solutions

- a. Pilot burner goes out (only models with manually-lit pilots):

- (1) check for insufficient gas supply, low gas pressure, a clogged pilot filter, or a closed or partially closed gas supply valve.
- (2) check for excessive carbon build-up on the thermocouple and clean as required.
- (3) check for a faulty thermocouple and replace as required.
- (4) readjust pilot flame until a faint yellow tip appears.
- (5) check for a faulty ignition or reset valve and replace as required.
- (6) check for excessive back drafts.

- b. Pilot burner does not light:

- (1) check for a closed or partially closed gas supply valve, a clogged pilot filter, or an obstruction in the gas supply line.
- (2) check setting on pilot switch and reset as instructions direct.

c. Pilot burner is okay but main burner does not light:

- (1) check for insufficient gas supply, a partially closed gas supply valve, or an obstruction in the gas supply line.

Note: Gas pressure may be enough to keep the pilot burner lit, but not enough to keep the main burner going.

- (2) check for a defective safety thermostat and replace as required.

Note: The service manual should have instructions for testing the thermostat.

- (3) check for incorrect air supply and readjust the air shutter on the gas burner until a bright blue flame appears.

- (4) check gas valve solenoid and replace solenoid as required or replace gas valve.

d. Main burner cycles (comes on and goes off) too fast:

- (1) check for loose connections at wiring terminals and tighten as required.
- (2) check for a faulty timer and replace timer motor or timer as required.
- (3) check for a faulty operating thermostat and replace as required.
- (4) check safety thermostat for erratic cycling because of restricted air flow, and clean lint or obstructions from the dryer as required.
- (5) check safety thermostat for proper operation and replace as required.

e. Main burner goes out after lighting:

- (1) check for low gas pressure, partially closed gas supply valve, or an obstruction in the gas supply line.
- (2) check the primary air adjustment and adjust the air shutter until a bright blue flame appears at the main burner.
- (3) check for loose connections at terminals and tighten as required.

**Automatic Dryers
Unit 8****Job Sheet 1—Install an Automatic Dryer**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Installation area inspected and acceptable	_____
Electrical connections/grounding correctly completed	_____
Dryer vented to specifications	_____
Dryer operated to verify correct installation	_____
Gas dryer safely installed and operated (optional)	_____
Customer instructed about operation and maintenance	_____

A. Tools and materials

Dryer (electric and/or gas) as selected by instructor
Standard hand tools and tool box
VOM
Level
Dolly
Safety glasses

B. Procedure

- ☐ 1. Put on safety glasses.
- ☐ 2. Uncrate the dryer carefully.
- ☐ 3. Inspect the dryer visually to make sure it has not been damaged in shipment.
- ☐ 4. If it must be moved any distance to the installation site, secure the dryer on a dolly.

Job Sheet 1

- ☐ 5. Inspect the location where the dryer will be for a level, sturdy floor.

Note: If the floor has problems, point out to the customer the condition could impair performance and eventually damage the dryer. If the customer wants the floor to remain as it is, have the customer sign a release.

- ☐ 6. Check the electrical supply to make sure:

- (a) there is a 240V three-wire, single-phase outlet for an electric dryer.

Note: The power wiring from the circuit breaker must be a minimum #10 AWG three-wired cable fused with a 30-amp or large slow-blow or time-delay fuse breaker.

- (b) that the outlet meets local code requirements.

- ☐ If the installation is for a gas dryer, make sure:

- (a) there is a three-hole grounded 120V receptacle for a gas dryer.

- (b) that an adequate gas supply is available for the gas dryer, and that it is a minimum $\frac{1}{2}$ " line, if it is no more than 20 feet from the gas meter.

Note: On runs longer than 20 feet, $\frac{1}{2}$ " pipe is not large enough, so check with local codes, and in cases where LP gas instead of natural gas is used, 3.8" copper tubing can probably be used.

- (c) that the gas supply line has an easy-to-reach shut-off valve near the dryer.

- ☐ 7. Whether the dryer is gas or electric, make sure there is an adequate air supply in the dryer location.
- ☐ 8. Remove ties, blocks, tape, and any other retaining devices installed to protect the dryer during shipment.
- ☐ 9. Check inside the dryer for the Owner's Manual and any other materials that should be saved.
- ☐ 10. Adjust leveling legs as need to level the dryer side to side and front to back.

Job Sheet 1

- ☐ 11. To check operation of an electric dryer, use the following procedure:
- (a) plug the power cord into a 240V receptacle,
 - (b) place enough clothes in the drum to test tumbling action, and
 - (c) operate the dryer through one timed cycle, and take care to note undue heat build-up that may indicate ventilation problems or improper venting.
- ☐ 12. To check the operation of a gas dryer, use the following procedure:
- (a) plug the power cord into a 120V receptacle.
 - (b) connect the gas supply line, open the shut-off valve, and use a soap and water solution to test for leaks.

Caution: Never use a match or other open flame to test for leaks; bubble action from a soap and water solution is safe and dependable.
 - (c) turn the gas off,
 - (d) begin purging by loosening the connection between the shut-off valve and the burner assembly.
 - (e) turn the gas on and let it flow until you hear or smell gas escaping through the loosened connection, and then turn the gas off,
 - (f) tighten the loose connection and turn the gas back on,
 - (g) start dryer until ignition occurs,

Note: You may have to try to start a pilotless dryer several time, and there may also be an erratic clicking noise until ignition occurs.
 - (h) place enough clothes in the drum to test tumbling action, and
 - (i) operate the dryer through one normal cycle, and take care to note undue heat build-up that would indicate ventilation problems or improper venting.
- ☐ 13. Explain operating procedure to the customer, and encourage the customer to follow recommended procedures for care and maintenance.
- ☐ 14. Clean up installation area and make sure all crating materials or blocks and ties are removed from the customer's residence.

Job Sheet 1

- ☐ 15. Remind the customer that your company should be called for any questions about dryer performance.
- ☐ 16. Check the work order to make sure you have recorded the serial number and other needed warranty information, including the date.
- ☐ 17. Compliment the customer on making a wise dryer selection, and leave the customer on a positive note.
- ☐ 18. Have your instructor check your work.
- ☐ 19. Return tools and materials to proper storage.

Comments: _____

Automatic Dryers Unit 8

Job Sheet 2—Troubleshoot a Whirlpool/Kenmore Automatic Dryer for Typical Malfunctions

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Timer and control panel troubleshooting complete and correct	_____
Door switch troubleshooting complete and correct	_____
Motor troubleshooting complete and correct	_____
Thermostat troubleshooting complete and correct	_____
Heating element troubleshooting complete and correct	_____
Repair log complete with problems noted	_____

A. Tools and materials

Dryer with service literature as selected by instructor
 Standard hand tools and tool box
 Motor test cord
 Drop cord/inspection light
 Drop cloth
 VOM
 Wattmeter
 Temperature tester
 Repair log (attached)
 Safety glasses

B. Routine 1—Troubleshoot the timer

- ☐ 1. Sign on your repair log.
- ☐ 2. Place drop cloth down, set the tool box on it, and arrange the tools and test equipment you will be using.
- ☐ 3. Put on your safety glasses.

Note: Safety glasses should be worn during all activities in a repair shop, and even on a residential service call, safety glasses are still recommended.

Job Sheet 2

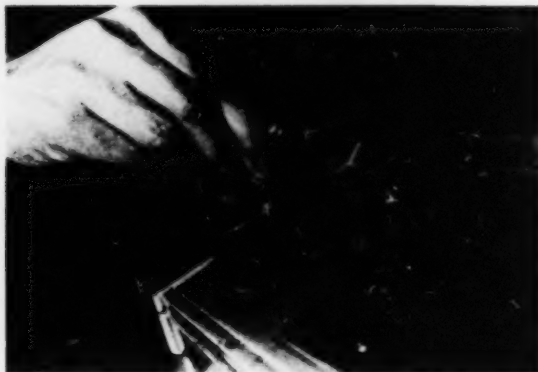
- ☐ 4. Transfer all nameplate information on the dryer nameplate to your troubleshooting log.



- ☐ 5. Unplug the power supply cord to the dryer.

Note: In the case of a gas dryer, also shut off main gas supply and disconnect gas line to the dryer.

- ☐ 6. Disconnect the dryer vent duct and be careful not to damage it.
- ☐ 7. Remove the timer knob by pulling it straight off and note the location of the flat section on the knob and on the timer shaft so you can put the timer knob back on properly.



- ☐ 8. Remove the console rear panel retaining screws and remove the rear panel.
- ☐ 9. Remove the console front panel retaining screws, but do not remove the front panel unless you cannot get the timer out through the open back panel.
- ☐ 10. Disconnect all conductor leads to the timer but be sure to note where they go by sketching a pictorial diagram to help you remember.

Job Sheet 2

- ☐ 11. Remove the timer.
- ☐ 12. Check the time motor with the following procedure:
 - (a) remove the motor from the timer,
 - (b) make a continuity test of the timer motor and record your reading: _____, and,
 - (c) conduct an electrical test of the timer motor by making a reference mark on the motor shaft and housing and then using a test cord to run the motor for at least ten minutes.
- ☐ 13. Have your instructor check your electrical test.
- ☐ 14. Replace the entire timer if the timer motor is bad.
- ☐ 15. Remount the timer but do not reconnect the conductors.
- ☐ 16. Replace the timer dial and knob.
- ☐ 17. Test the timer switch contacts with the following procedure:

Note: Before attempting any checks on the timer, refer to a timer sequence chart, make sure you understand it, and that the wiring diagram is with it.

 - (a) move the timer dial to any heat cycle, preferably the time dry cycle about midway in the cycle, but not on the first five minutes,
 - (b) zero your VOM, touch one probe in terminal Y and the other probe to terminal R on the timer,
 - (c) the VOM should read zero ohms resistance, and if not, the timer is bad and should be replaced, and
 - (d) check remaining timer contacts according to timer sequence chart.
- ☐ 18. Replace the old timer or install a new timer as test indicates.
- ☐ 19. Put all conductors back in place and reinstall the control panel.
- ☐ 20. Have your instructor check your work.
- ☐ 21. Note on your repair log how long it took you to accomplish Routine 1.

Job Sheet 2

C. Routine 2—Troubleshoot the door switch

Note: The door switch functions to stop the dryer when the door is opened, and, depending on the model, it may also turn on the inspection light in the drum.

- ☐ 1. Sign on your repair log.
- ☐ 2. Check your service manual to see how the door switch is mounted on the dryer model on which you are working.
- ☐ 3. Raise the top of the dryer and secure it.
- ☐ 4. Check your service manual for the correct way to remove the top of the model on which you are working.

Note: Generally, on dryers with the lint filter mounted in the top of the lid, there are two mounting screws securing the top to the vent housing, and these mounting screws are located underneath the lint screen cover; remove the screws.



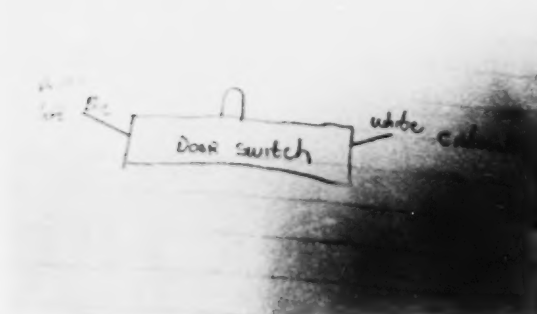
- ☐ 5. Use a putty knife and place the blade between the top and the front of the cabinet at a corner about two inches from the edge.

Job Sheet 2

- ☐ 6. Push in on the putty knife to release the retaining clip while lifting up on the corner of the top, and then repeat the procedure on the opposite corner.



- ☐ 7. Make a pictorial sketch of the conductors to the door switch and label each one according to the terminal markings on the door switch.



- ☐ 8. Remove all conductors.
- ☐ 9. Remove the switch (check the service manual).
- ☐ 10. Make a continuity check of the switch:
- (a) with door switch in the closed position, test for continuity across the COM (common) terminal and the NO (normally open) terminal,
 - (b) VOM should read zero ohms,
 - (c) if reading is not zero ohms, the door switch is bad and should be replaced,

Job Sheet 2

- (d) if door switch is a three-terminal switch (COM, NO, AND NC) with no pressure applied to the switch, this should be the NC of door switch,
 - (e) test across terminals COM and NC for a resistance reading of zero ohms, and
 - (f) if reading is not zero ohms, switch is faulty and should be replaced.
- ☐ 11. Inspect switch mounting bracket and lever assembly for breaks or signs of wear, and if there is evident wear, replace the bracket.



- ☐ 12. Have your instructor check your work.
- ☐ 13. Reinstall the old switch or install a new switch as test indicates.
- ☐ 14. Replace conductors properly.
- ☐ 15. Note on your repair log how long it took you to accomplish Routine 2.
- ☐ 16. Have your instructor check your work.

Job Sheet 2

D. Routine 3—Troubleshoot the motor

- ☐ 1. Sign on your troubleshooting log.
- ☐ 2. Raise and secure the top of the dryer.
- ☐ 3. Remove the lower front inspection panel.

Note: Some models are different; check your service manual.

- ☐ 4. Remove the drum with the following procedure:
 - (a) remove the drive belt by using one hand to push the idler pulley toward the motor shaft,
 - (b) use the other hand to remove the drive belt off the motor pulley,



- (c) slip the drive belt under the idler pulley and remove it from the drum, and,
- (d) lift and pull forward to remove the drum.



Note: This procedure is only for models without a drum bearing; if you are working on a model with a drum bearing, check your service manual.

Job Sheet 2

- ☐ 5. Inspect the motor for lint and debris, and clean motor with compressed air if it needs it.



- ☐ 6. Remove the conductors coming from the main wiring harness to the motor and sketch a pictorial diagram labeling each conductor according to its terminal marking (color code/numbers), and verify connections on a wiring diagram.
- ☐ 7. Make a continuity test of the motor/start switch with the following procedure:
- (a) disconnect internal motor conductor leads from start switch and identify their locations,
 - (b) using VOM, check continuity between the yellow and blue conductor leads,
 - (c) the VOM should show 1 to 5 ohms on the ohm scale,
 - (d) if you get any other reading, the motor is faulty and should be replaced,
 - (e) make a continuity test between the black and blue conductor leads,
 - (f) the VOM should show 1 to 5 ohms on the ohm scale,
 - (g) if you get any other reading, the motor is faulty and should be replaced,
 - (h) remove start switch from front of motor with a standard screwdriver,

Caution: When replacing a start switch be sure to use the correct switch for the motor because different motors require different start switches.

Job Sheet 2

- (i) using VOM, make the following continuity checks,
 - (j) check continuity between terminals 1 and 2 on the start switch with the start switch button in the "out" position or no pressure applied,
 - (k) the VOM should indicate zero ohms, and if not, the switch is bad and should be replaced,
 - (l) check continuity between terminals 5 and 6 on the start switch with the start switch button in the "out" position or no pressure applied,
 - (m) the VOM should indicate zero ohms, and if not, the switch is bad and should be replaced,
 - (n) check continuity between terminals 5 and BK with the start switch button in the "out" position and no pressure applied,
 - (o) the VOM should indicate infinite resistance or an open circuit, and if not, the switch is bad and should be replaced,
 - (p) repeat steps j, l, and n with the start switch button in the "in" position or pressure applied,
 - (q) look for continuity readings as follows: between 1 and 2 should be infinite ohms or an open circuit, between 5 and 6 should be infinite ohms or an open circuit, and between 5 and BK should show zero ohms, and
 - (r) if all or any of one of the readings is not correct, the switch is faulty and should be replaced.
- ☐ 8. Have your instructor check your work.
- ☐ 9. Reinstall motor switch and internal motor leads if the tests indicate everything is okay.
- ☐ 10. Test run the motor using 115V motor test cord:
- (a) connect the black test motor lead to #5 start switch terminal,
 - (b) connect the white test motor lead to #4 start switch terminal,
 - (c) place a clamp around ammeter around the white motor test cord lead, and set the ammeter scale,

Job Sheet 2

- (d) turn motor test cord to the RUN position,



- (e) if the motor fails to start and run or draws too much current, shut off test cord,
- (f) motor probably has mechanical problems and should be replaced,
- (g) have your instructor check your work and recommend repair or replacement, and
- (h) if motor starts and runs, check amperage for a reading less than the amperage on the motor nameplate, and if it is otherwise, the motor is faulty and should be replaced.
- ☐ 12. Reinstall old motor or install new motor and start switch as directed.
- ☐ 13. Note on your repair log how long it took you to complete Routine 3.

Job Sheet 2

E. Routine 4—Troubleshoot the thermostats

- ☐ 1. Sign on your troubleshooting log.
- ☐ 2. Remove the rear service panel so the thermostats will be accessible.
- ☐ 3. Locate the operating or cycling thermostats in or on the blower housing.



- ☐ 4. Locate the high limit or safety thermostat in or on the heater box itself.



- ☐ 5. Isolate the thermostat you plan to check with the following procedure:
 - (a) sketch a pictorial diagram of each thermostat, its location, and note the color markings of each conductor and terminal on each thermostat, and
 - (b) remove the conductors, but leave the thermostats in place.

Job Sheet 2

- ☐ 6. Make continuity test with the following procedure:
- (a) check continuity across the two terminals of the high-heat (regular heat) cycling thermostat and record the reading,
 - (b) VOM should indicate zero ohms, and if not, thermostat is faulty and should be replaced,
 - (c) repeat the procedure for the medium-heat and low-heat cycling thermostats (if machine has two or more cycling thermostats),
 - (d) if any reading is other than zero ohms, the thermostat is faulty and should be replaced,

Note: A continuity reading may indicate a good thermostat, but the dryer still may cycle erratically because of thermostat problems, and a temperature check will sometimes be required to completely isolate the problem.

- (e) repeat the procedure for the high limit or safety thermostat, and
- (f) if the reading is other than zero ohms, the thermostat is faulty and should be replaced.

Note: Most thermostats have a fixed temperature setting, and in the case of the safety thermostat, that limit should be between 220°F and 325°F, and the thermostat range should be stamped somewhere on the body of the thermostat.

- ☐ 7. Have your instructor check your work.
- ☐ 8. Reinstall old thermostats or new ones as required, and replace conductors.
- ☐ 9. Reinstall the rear panel, plug the dryer into a power source, and cycle check the dryer.
- ☐ 10. Have your instructor check your work.
- ☐ 11. Note on your repair log how long it took you to accomplish Routine 4.

Note: In the event thermostats checked out okay but the cycling test indicates erratic cycling or improper drying, there is probably a faulty thermostat that can only be identified with a temperature check.

Job Sheet 2

F. Routine 5—Troubleshoot the thermostat cycling temperatures

- ☐ 1. Sign on your troubleshooting log.
- ☐ 2. Remove the rear panel.
- ☐ 3. Clamp the ammeter around the conductor between the high-limit thermostat and the heating element, and select the proper amperage scale.

Note: The ammeter will indicate amperage as the heating element cycles on and will indicate no amperage as the heating element cycles off, and these two points are the points where temperature checks should be made.

- ☐ 4. Insert temperature tester lead into the dryer exhaust duct, and place it as near the cycling thermostat as possible.



- ☐ 5. Check the high-heat cycling thermostat with the following procedure:
 - (a) select time-dry cycle approximately 25-30 minutes of drying time,
 - (b) make appropriate temperature selector switch setting for high-heat,
 - (c) start dryer,
 - (d) watch the ammeter scale to note when the heating element cycles off,
 - (e) record the temperature indicated at that exact moment by the temperature tester: _____,
 - (f) wait until the ammeter indicates the heating element has cycled on again,
 - (g) record the temperature indicated at that exact moment by the temperature tester: _____.

Job Sheet 2

- (h) repeat the procedure until you have at least three readings. Add your two temperature readings and divide the total by two to obtain an average cycling temperature: _____.
 - (i) Add all temperature readings and divide by the number of temperature readings made (in this case, six) to obtain an average cycling temperature: _____.
 - (j) check your average cycling temperature with the temperature listed on the high-heat cycling thermostat, and
 - (k) if the average temperature you obtained exceeds recommended tolerances, thermostat is faulty and should be replaced.
- ☐ 6. Repeat the previous procedure for all other thermostats.
 - ☐ 7. Have your instructor check your work.
 - ☐ 8. Replace the thermostats, if required, and reinstall the rear service panel, and cycle test the machine.
 - ☐ 9. Note on your repair log how long it took you to accomplish Routine 5.

Note: The total time dedicated to thermostat troubleshooting should be the times listed for both Routines 4 and 5.

G. Routine 6—Troubleshoot the heating element

- ☐ 1. Sign on your troubleshooting log.
- ☐ 2. Unplug the dryer and remove the rear service panel.
- ☐ 3. Sketch a pictorial diagram of the heating element terminals and conductors.
- ☐ 4. Remove one or both conductors from the heating element terminals.
- ☐ 5. Make a continuity check with the following procedure:
 - (a) take a reading across the two heating element terminals,

Note: In case of a three terminal element, check with your instructor or check your service manual.
 - (b) VOM reading should indicate between 5 and 50 ohms of resistance,

Job Sheet 2

- (c) if reading is otherwise, element is faulty and should be replaced,
 - (d) place one VOM probe on either terminal of the heater element,
 - (e) arc the other probe against the heater element housing and be sure you make good metal-to-metal contact,
 - (f) the VOM should indicate infinite resistance or an open circuit, and if it does not, the heating element is faulty and should be replaced, and
 - (g) check the other terminal as outline in steps d, e, and f and evaluate reading as outlined.
- ☐ 6. Have your instructor check your work.
- ☐ 7. Replace the heating element, if required, with the following procedure:
- (a) raise and secure the top,
 - (b) use a stubby screwdriver to remove the screw holding the clip that secures the heater housing to the bulkhead,
 - (c) remove the hex head screws that secure the high-limit thermostat to the heater housing,
 - (d) lift the heater housing upward from the bulkhead bracket to free it,
 - (e) pull down and out the rear of the dryer to remove the heater housing,
 - (f) remove the screw holding the heater element in the heater housing,
 - (g) remove the heating element carefully from the heater housing,
 - (h) install the new heating element by sliding it into the heater housing,
 - (i) secure the heating element to the heater housing with the screw that was removed,
 - (j) reinstall heater housing by reversing the previous procedure,
- Note: It is recommended that anytime a heating element is replaced that the high-limit thermostat also be replaced.
- (k) install new high-limit thermostat,
 - (l) replace conductor wires, close the top, and reinstall the rear service panel,

Job Sheet 2

- (m) reconnect the exhaust duct to the dryer,
 - (n) check to make sure dryer is level, and
 - (o) plug dryer in and cycle test it.
- ☐ 8. Have your instructor check your work.
 - ☐ 9. Note on your repair log how long it took you to accomplish Routine 6.
 - ☐ 10. Clean up area, and return tools and equipment to proper storage.

Comments: _____

**Automatic Dryers
Unit 8****Job Sheet 2****Repair Log**

Your name _____ Date _____

	Date	Time On	Time Off
Routine 1—Troubleshoot the timer			
Routine 2—Troubleshoot the door			
Routine 3—Troubleshoot the motor			
Routine 4—Troubleshoot the thermostats			
Routine 5—Troubleshoot the thermostat cycling temperatures			
Routine 6—Troubleshoot the heating element			

Note any special problems you encountered in any of your troubleshooting routines:

**Automatic Dryers
Unit 8****Job Sheet 3—Troubleshoot a GE/Hotpoint Automatic Dryer
for Typical Malfunctions**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
No heat complaint troubleshooting complete and correct	_____
Heating element troubleshooting complete and correct	_____
Timer troubleshooting complete and correct	_____
Repair log complete with problems noted	_____

A. Tools and materials

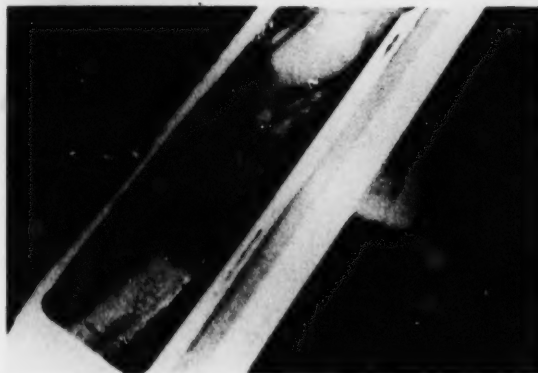
Dryer with service literature as selected by instructor
Standard hand tools and tool box
Appliance flipper
Drop cord/inspection light
Drop cloth
VOM
Repair log (attached)
Safety glasses

B. Routine 1—Troubleshoot a no heat complaint

- ☐ 1. Put on safety glasses.
- ☐ 2. Sign on your repair log.
- ☐ 3. Verify the complaint by attempting to run the dryer through a normal cycle.
- ☐ 4. Check the circuit breakers first, if there is a no heat problem, and make sure they are both properly set.
- ☐ 5. Unplug the dryer and open the dryer door.
- ☐ 6. Set your VOM on the R x 1 scale.

Job Sheet 3

- ☐ 7. Pull the lint filter out of the bottom of the door opening and remove one of the leads to the thermostat at the bottom of the filter assembly.



- ☐ 8. Place one VOM lead on each terminal of the thermostat and look for a reading of little or no resistance:
- (a) if there is a full scale deflection followed by a measurement of little or no resistance, the thermostat is okay,
 - (b) if there is no full scale deflection and no reading at all, the thermostat should be replaced.
- ☐ 9. Check the number of terminals on the thermostat and the L number which indicates the operating temperature limit and refer to the good parts catalog to get the correct GE/Hotpoint replacement thermostat.
- ☐ 10. Remove the old thermostat and replace it with the new one, and put the leads onto the correct terminals.
- ☐ 11. Use a putty knife to release the springs on each side and then turn the lid back, or newer models may have screws that have to be removed in order to raise the lid.



Job Sheet 3

- ☐ 12. Look for the upper limit thermostat mounted on the top of the heater element housing.
- ☐ 13. Make a continuity check on the upper limit thermostat with the same procedure used for the operating thermostat.



- ☐ 14. Replace the upper limit thermostat as required.
- ☐ 15. Have your instructor check your work.
- ☐ 16. Replace the lid, close the door, plug the dryer in to a grounded receptacle and run the dryer through a normal cycle:
 - (a) if the dryer performs properly, the new thermostat(s) has solved the problem.
 - (b) if the dryer still does not heat, check the heating element as outlined in the next routine.

C. Routine 2—Troubleshoot the heating element

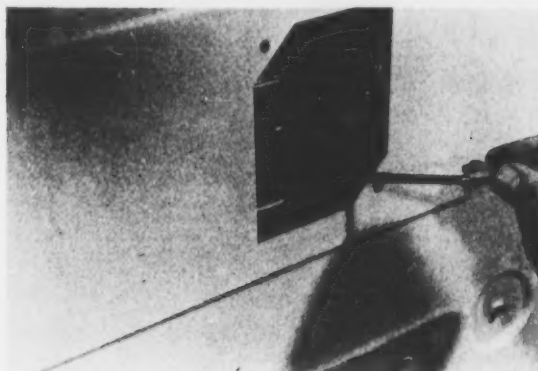
- ☐ 1. Sign on your repair log.
- ☐ 2. Unplug the dryer from its power source.
- ☐ 3. Release the lid and fold it back.

Job Sheet 3

- ☐ 4. Reach down behind the right hand side of the door and remove the leads from the door switch, making sure you note the color coding so you can properly replace the leads.



- ☐ 5. Remove the top inside screws that secure the front panel to the cabinet.
- ☐ 6. Lift the front panel up a bit to free it, and then set it aside.
- ☐ 7. Go to the back of the dryer and use a nut driver to remove the cover plate that protects the drum spindle.
- ☐ 8. Reach in with a small screwdriver and remove the snap ring that secures the drum spindle.



Job Sheet 3

- ☐ 9. Reach in at the bottom of the drum at the end of the motor shaft and depress the tension spring, and then remove the belt while you have the spring depressed.



- ☐ 10. Pull out and lift up to remove the drum, and set it safely aside.



- ☐ 11. Inspect the heating elements, the two nichrome coils, for breaks where they may have burned in two.
- ☐ 12. Check the heating elements with the VOM set at R x 1 if there are no evident breaks in the elements:
- (a) if the heating elements register a full scale deflection, it means they are okay.
 - (b) if there is no meter movement, the heating elements are bad and should be replaced.

Job Sheet 3

- ☐ 13. Replace bad elements with a restring kit.

Note: Restring kits are much less expensive than complete replacement elements, but restringing requires even spacing of the coils through the insulators, and you should ask your instructor to demonstrate the procedure.

- ☐ 14. Replace the drum, the snap ring that secures the drum spindle at the back of the dryer, and replace cover plate.

Note: Make sure the brass leaf ground is making contact with the end of the drum spindle because this serves to not only ground that part of the dryer, it also serves to eliminate static electricity which might cause interference with radios.



- ☐ 15. Replace the front panel, replace the leads to the door switch, and put the lid back in place.
- ☐ 16. Have your instructor check your work.
- ☐ 17. Plug the dryer in to a grounded receptacle and start it through a normal cycle.

Job Sheet 3

- ☐ 18. Place a temperature probe into the dryer exhaust and monitor the temperature throughout the normal cycle.



- ☐ 19. Run the dryer through whatever other cycles are available (wash and wear, delicate) and check the temperature.
- ☐ 20. Check with your instructor for manufacturer's temperature requirements and compare your temperature findings to verify correct temperature ranges.
- ☐ 21. Have your instructor check your work.

D. Routine 3—Check the timer

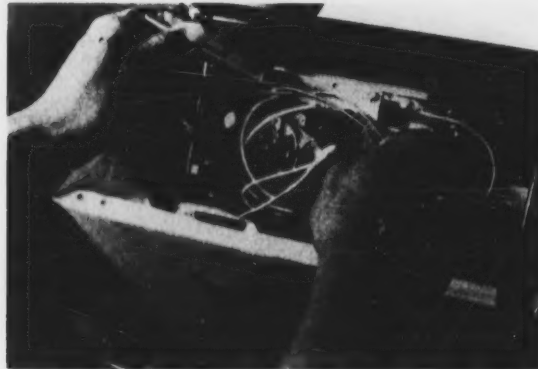
- ☐ 1. Sign on your repair log.
- ☐ 2. Unplug the dryer from its power source.

Note: This procedure should be used for complaints that the timer will not advance or not turn on at all.

- ☐ 3. Remove the screws on each end of the console and fold the console down over the lid.
- ☐ 4. Plug the dryer back in to a grounded receptacle.

Job Sheet 3

- ☐ 5. Make a check of the voltage going into the timer, and the voltage coming out of the timer:



- (a) if the voltage coming out of the timer is the same as the voltage going into the timer, the timer is okay.
- (b) if there is not voltage coming out of the timer, the contacts are burned and the timer will have to be replaced with a new timer.

Note: Unlike the GE/Hotpoint washer timer which can be repaired, the dryer timer is an integrated unit and has to be replaced as a unit.

- ☐ 6. Unplug the dryer and replace the timer as required.
- ☐ 7. Put the console back in place.
- ☐ 8. Plug the dryer in and run it through a complete cycle.
- ☐ 9. Have your instructor check your work and sign off your repair log.
- ☐ 10. Clean up the area and return tools and materials to proper storage.

**Automatic Dryers
Unit 8****Job Sheet 3****Repair Log**

Your name _____ Date _____

	Date	Time On	Time Off
Routine 1—Troubleshoot a no heat complaint			
Routine 2—Troubleshoot the heating element			
Routine 3—Check the timer			

Note any special problems you encountered in any of your troubleshooting routines:

Automatic Dryers
Unit 8

MAR-313

Job Sheet 4—Troubleshoot a Microprocessor Control Panel
for Typical Malfunctions

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Self-diagnostic tests completed per service manual	_____
Control panel removed and replaced, if required	_____
Touchpad checked for proper resistance readings	_____
Primary and secondary sides of transformer checked for resistance	_____
Primary and secondary sides of transformer checked for voltage	_____
Transformer reinstalled or replaced as required	_____
Repair log complete with problems noted	_____

A. Tools and materials

Dryer with service literature as selected by instructor
Control panel service literature
Standard hand tools and tool box
VOM
Repair log (attached)
Safety glasses

B. Routine 1—Run self-diagnostic tests on a control panel

- ☐ 1. Sign on your repair log, and consult service literature for recommended troubleshooting routine.

Note: Some microprocessors have self-diagnostic capabilities. Consult service literature to determine if microprocessor board is capable of self-diagnostic tests. If board is capable of self-diagnostics, complete self-diagnostic procedure according to instructions in service literature.

- ☐ 2. Troubleshoot board following procedure in service literature.
- ☐ 3. If self-diagnostics or troubleshooting procedure indicate board is normal, skip the remaining steps in this routine and go on to Routine 2.

Job Sheet 4

- ☐ 4. If self-diagnostics or troubleshooting indicate board is defective, continue routine to remove and replace board.
- ☐ 5. Sign on repair log, and put on safety glasses.
- ☐ 6. Disconnect dryer power cord.
- ☐ 7. Locate the control panel and open for access according to instructions in service literature.
- ☐ 8. Remove control panel according to instructions in service literature.
- ☐ 9. Disconnect microprocessor board and remove according to instructions in service literature.
- ☐ 10. Install new microprocessor board and connect according to instructions in service literature.
- ☐ 11. Reinstall control panel according to instructions in service literature.
- ☐ 12. Plug in dryer and check new control panel.
- ☐ 13. If self-diagnostics indicate that board is normal, sign off your repair log and continue testing control panel according to procedure in Routine 2.

C. Routine 2—Check touchpad

- ☐ 1. Sign on your repair log and put on safety glasses.
- ☐ 2. Disconnect dryer power cord.
- ☐ 3. Locate the control panel and open for access according to instructions in service literature.
- ☐ 4. Remove control panel according to instructions in service literature.
- ☐ 5. Disconnect microprocessor board and remove from control panel according to instructions in service literature.

Job Sheet 4

- ☐ 6. Using VOM check touchpad for correct resistance with pads pressed and open, according to instructions in service literature. Record the connections and your findings in the space below:

Note: The touchpad is connected to the microprocessor board by a ribbon connector that contains conductive strips. The number of strips and their contacts vary by make and model of dryer. Consult appropriate service literature to determine proper contacts and resistance readings.

- ☐ 7. Reinstall or replace touchpad as required according to instructions in service literature and sign off repair log.

D. Routine 3—Check transformer

- ☐ 1. Sign on your repair log and put on safety glasses.
- ☐ 2. Disconnect dryer power cord.
- ☐ 3. Consult service literature for location of transformer.
- ☐ 4. Locate transformer and remove according to instructions in service literature.
- ☐ 5. Using VOM, check primary side of transformer for continuity and resistance as specified by service literature. Record your findings in the space below:
- ☐ 6. Using VOM, check secondary side of transformer for continuity and resistance as specified by service literature. Record your findings in the space below:
- ☐ 7. Using VOM, check voltage on primary side of transformer as specified by service literature. Record your findings in the space below:

Caution: Live voltage checks require extreme caution. Always make certain that power cord to dryer is disconnected when you are connecting or disconnecting VOM leads.

Job Sheet 4

- ☐ 8. Using VOM, check voltage on secondary side of transformer as specified by service literature. Record your findings in the space below:

Caution: Live voltage checks require extreme caution. Always make certain that power cord to dryer is disconnected when you are connecting or disconnecting VOM leads.

- ☐ 9. Disconnect dryer power cord.
- ☐ 10. Reinstall or replace transformer as required, according to instructions in service literature.
- ☐ 11. Sign off your repair log.
- ☐ 12. Have your instructor check your work.
- ☐ 13. Clean area and return tools and materials to proper storage.

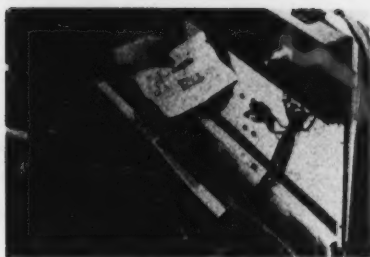
Comments _____

**Automatic Dryers
Unit 8****Job Sheet 4****Repair Log**

Your name _____ Date _____

	Date	Time On	Time Off
Routine 1—Run self-diagnostic tests on microprocessor board			
Routine 2—Check touchpad			
Routine 3—Check transformer			

Note any special problems you encountered in any of your troubleshooting routines:

Automatic Dishwashers**Unit 9****Objective Sheet****Unit Objective**

After completing this unit, the student should be able to install an automatic dishwasher under a counter, troubleshoot malfunctions on an automatic dishwasher, and inspect the seal on an automatic dishwasher. The student should demonstrate these competencies by completing the activities in the job sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should:

1. Match terms related to automatic dishwashers with their correct definitions.
2. Match major components of a dishwasher with their functions.
3. Arrange in order the typical steps in an automatic dishwasher cycle.
4. Complete statements about special considerations for dishwasher installation.
5. Select true statements about water problems with dishwashers.
6. Complete statements about loading order in dishwasher operation.
7. Match dishwasher misuses with their causes.
8. Select true statements about guidelines for better dishwasher service.
9. Select true statements about guidelines for troubleshooting automatic dishwashers.
10. Complete a list of ways to prevent mineral build-up in an automatic dishwasher.
11. Complete statements about troubleshooting redeposit problems.
12. Install an automatic dishwasher under a counter. (Job Sheet 1)
13. Troubleshoot malfunctions on an automatic dishwasher. (Job Sheet 2)
14. Inspect the seal on an automatic dishwasher. (Job Sheet 3)

**Automatic Dishwashers
Unit 9**

Information Sheet

1. Terms and definitions

- a. **Hard water**—Water containing mineral salts in quantities enough to interfere with lathering, sudsing, or cleaning properties of soaps and detergents
- b. **Lime build-up**—A mineral deposit that remains after a substance containing calcium carbonate is subjected to heat
- c. **Purge**—The process of running cold water out of a hot water supply line to assure that only hot water of a desired temperature will be available
- d. **Rinsing agent**—Chemicals added to water during a rinse cycle to enhance removal of chemical or detergent residue from dishes
- e. **Soft water**—Water such as rainwater that contains none or few mineral salts
- f. **Water softener**—Any chemical that removes mineral salts from water or a filtering device that uses chemicals to remove minerals from water

2. Major components of a dishwasher and their functions

- a. **Timer**—The electromechanical "brain" of an automatic dishwasher because it controls the operations of other components in a predetermined sequence

Note: Refer to Student Supplement 1.
- b. **Inlet valve**—Controls water flow through the inlet hose into the tub
- c. **Motor**—The source of power for driving the impeller that spins to complete the washing cycle
- d. **Heating element**—The device that maintains water temperature and provides heat for the hot air used during the drying cycle
- e. **Pump**—Forces water through the spray arms during the wash and rinse cycles and forces water and food particles out of the dishwasher during pumpout
- f. **Spray arms**—Perforated extensions that reach out horizontally below and above the dishracks to provide a route for the revolving pressurized hot water that is sprayed onto the dishes
- g. **Filter**—The device that separates food particles from the water so they will not be sprayed back onto the dishes

Information Sheet

- h. **Drain valve**—Directs dirty water and food particles away from the dishwasher into a drain system
- i. **Door/lid switch**—Keeps the tub from filling until the door is closed to eliminate the prospects that water will spray out of an open door or lid into the kitchen
- j. **Dispensers**—Devices for releasing detergent and rinsing agent
- k. **Float switch**—Safety device to prevent overfilling

3. Typical steps in a automatic dishwasher cycle

- a. Dirty dishes should be properly arranged in the dishracks.

Note: Refer to the timer sequence in Student Supplement 2.

- b. Detergent as recommended by the manufacturer, and in the proper quantity, should be placed in the detergent dispenser.
- c. Rinse conditioner should be added as recommended or as local water conditions demand.
- d. Water enters the tub through the inlet hose and inlet valve until there is approximately two gallons of water in the tub.
- e. The heating element is energized to assure that the water will be at least 140°F.
- f. The motor is energized and pumps hot water through the lower spray arm in a jet stream and over the dishes to the upper spray arm.
- g. The upper spray arm deflects the water back down over the dishes and the washing action between the lower and upper spray arms is repeated over and over again.
- h. As water runs off the dishes, it flows through a filtering system to keep food particles from being sprayed back onto the dishes.
- i. As each wash or rinse cycle ends, water is pumped out of the dishwasher and small food particles are flushed away with it.
- j. As the drying cycle starts, the heating element comes on so that hot air can be circulated over and around the dishes to help dry them.

Information Sheet**4. Special considerations for dishwasher installation**

- a. There must be a proper 120V power supply, and it is recommended that the circuit be equipped with a 15-amp time delay fuse.
- b. Dishwasher must be properly grounded.
- c. Extension cords should not be used to extend the power supply because they usually result in low line voltage.
- d. Low line voltage does not permit the motor to operate at its rated capacity and results in poor washing action and water circulation.
- e. A dishwasher should be installed only on a sturdy, level floor in a well ventilated area.
- f. Dishwasher drain hookups must be near the equipment and free of obstructions that might impair proper drainage.
- g. The water supply must have a minimum flow rate of three gallons per minute and a minimum pressure of 15 psi.

Note: Pressure too high needs to be moderated with a pressure regulator in the water line so that the inlet hose and fill valve will not be damaged. Low water pressure usually demands an analysis of the water supply system.

- h. Water supply must also be in the range of 140°F to 160°F because some detergents will not dissolve and work at lower temperatures, and the higher temperature also helps in the drying cycle.

5. Water problems with dishwashers

- a. Loading patterns vary with design, so follow operator's manual carefully.
- b. Stains on dishes result from minerals found in "hard" water or rust that comes from the metal piping.

Note: More than 75% of the water supplies in America are classified as hard water.

- c. When piping is so old that rust cannot be controlled, it should be replaced.
- d. Minerals in the water not only cause stains, they lead to lime build-up even in cases where the detergent recommended is designed to fight lime buildup.
- e. Cleaning the dishwasher with vinegar or citric acid will help control lime build-up.

Information Sheet

- f. The best way to control stains, spots, and lime build-up is to install a water softener/filter in the water supply line.

Note: In cases where the water is extremely hard, the filtering water softener is the only means of controlling the situation, and specific types of hard water may require an iron or manganese filter.

6. Loading order in dishwasher operation

- a. Each model dishwasher has its own spray or splash pattern for water action and the order in which dishes are loaded must facilitate dishwasher design.
- b. Common sense is the best aid to proper placement, but generally, nothing should be placed on one rack that would block the flow of water to another rack.
- c. Cups and glasses and any containers that will retain water should always be placed upside down so water will drain from them and they will dry.
- d. Keep flatware and other utensils in their proper baskets because they can puncture seals and create problems if they are in the wrong place.

7. Common dishwasher misuses and their causes

- a. Improper dishrack loading—Results from careless neglect of instructions or when dishes are loaded by a child or other person unfamiliar with loading order
- b. Improper dish preparation—Results when dishes or utensils with dried food caked on them are not wetted and scraped before loading
- c. Careless dish preparation—Results when small bones or large seeds are carelessly left on dishes

Note: Bones and seeds inevitably reach the pump clog or damage it.

- d. Improper detergent use—Results when soap flakes or soap powders are used instead of the recommended detergent

Note: Soap flakes or powders form so much suds that they actually form a barrier that keeps the water spray away from the dishes.

8. Guidelines for better dishwasher service

- a. When a dishwasher is hooked up with a garbage disposer, the disposer should be completely empty so water will drain freely through the disposer.
- b. Before starting the dishwasher, run hot water at the sink to purge cold water out of the line and assure that only hot water enter the dishwasher.

Note: Remembering to run the cold water off can help solve problems with spotting and general dishwasher performance.

Information Sheet

- c. The same amount of water goes through a dishwasher each time it is used, so even when washing half a load, enough detergent for a full load should be placed in the dishwasher.

9. Guidelines for troubleshooting automatic dishwashers

- a. Before assuming anything about a malfunctioning dishwasher, remember that almost 75% of dishwasher problems are not related to component failures.
- b. Check for a proper 120V electrical power source.
- c. Check for a hot water supply of 140°F to 160°F and for a minimum water pressure of 15 psi.
- d. Check for a faulty floor that may be causing the dishwasher to vibrate or a poor installation that does not provide ventilation.
- e. Make sure the dishwasher is not being operated with improper detergent, loaded improperly, or subjected to other forms of abuse.
- f. Check the removable panel at the back or front of the machine for a schematic wiring diagram and compare it with the operating sequence of the timer to systematically track down other problems.
- g. Refer to the manufacturer's service chart for specific problems.
- h. Look for leaks or broken parts, listen for parts that are binding, and generally use your senses and your common sense to diagnose the problem properly.

Note: If you cannot find the problem, you cannot repair it, and when you do not proceed in an orderly manner, you stand a good risk of creating another problem or a bigger problem.

- i. Check with customer to see if shower or laundry use is depleting the hot water supply.

10. Ways to prevent mineral build-up in an automatic washer

- a. Check the washer at regular intervals for the presence of a white, brown, or yellow build-up in the tub.

Note: The color of the deposit is a good clue to the type of water filter that would solve the problem; white indicates an excess of manganese in the water, brown indicates an excess of iron, and yellow indicates an excess of sulphur.

Information Sheet

- b. When build-up is enough that it can be readily detected, Whirlpool recommends the following procedure:

- (1) empty the dishwasher and set it for a one wash cycle,
- (2) start dishwasher, and then open the door so it will stop when it has filled enough for the wash cycle,
- (3) add half a cup of citric acid crystals to the tub,
- (4) close the door latch and allow the dishwasher to complete the cycle, and
- (5) run another complete wash and rinse cycle to clean remaining residue from the tub and drain system.

- c. An alternate method of controlling lime build-up is to add two cups of distilled white vinegar to the tub instead of citric acid crystals.

- d. In areas where a brown stain is deposited on dishes, a quarter of a teaspoon of oxalic acid crystals used after dishes are washed should remove the iron deposits from the dishes.

Note: Do not use the crystals and the detergent together, and follow the cycle using crystals with another cycle using detergent.

- e. Build-ups of tea stains on cups and saucers usually have to be removed by hand with a wash cloth saturated with baking soda.

11. Troubleshooting redeposit problems

- a. Because redeposits leave white spots on dishes, everyone assumes the spots are undissolved detergent, but they may be undissolved starch from foods.
- b. To isolate the problem, place a glass or dish under hot water:
- (1) if the spots dissolve quickly in hot water, it is a detergent problem,
 - (2) if the spots stick to the glass or dish, they are food starches.
- c. Detergent problems can be corrected by changing to a different detergent or mixing detergent with water conditioner.
- d. Food starch problems require better precleaning, especially with containers used for mashed potatoes, cooked cereals, cream soups, and any pudding or dessert that has a cornstarch base.

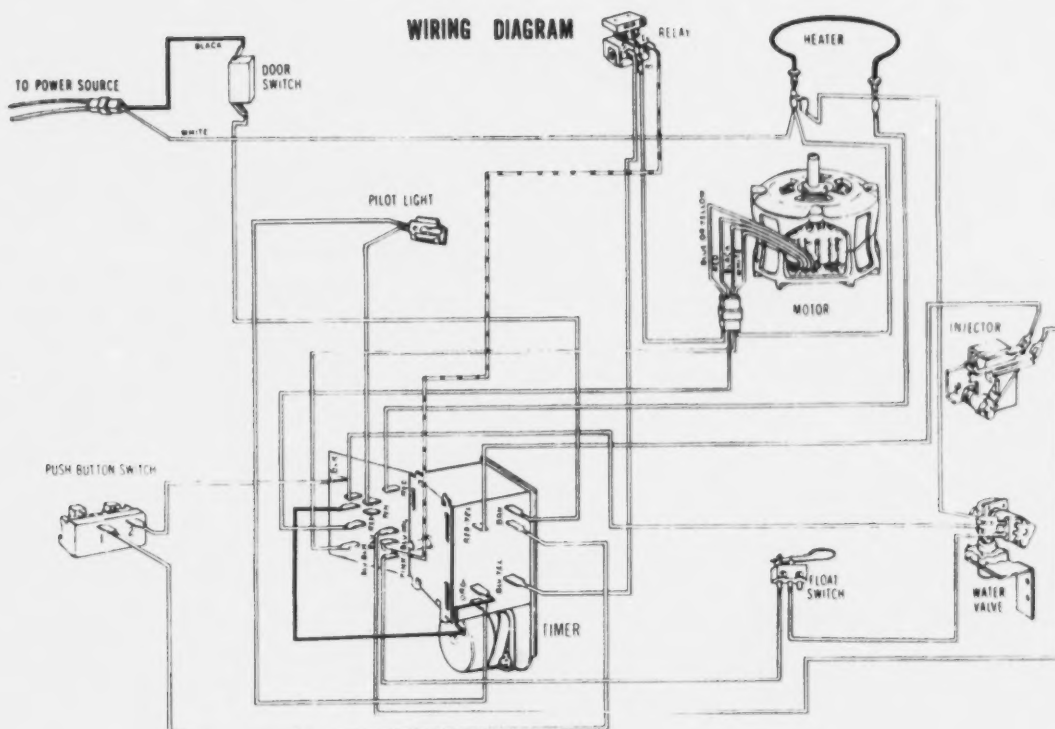
Information Sheet

- e. Both problems may be related to improper water temperature and require adjustment of the hot water supply control.

Note: Water under 140°F will not dissolve detergent nor hold food soil in suspension, and water over 160°F will bake food particles onto dishes.

Automatic Dishwashers Unit 9

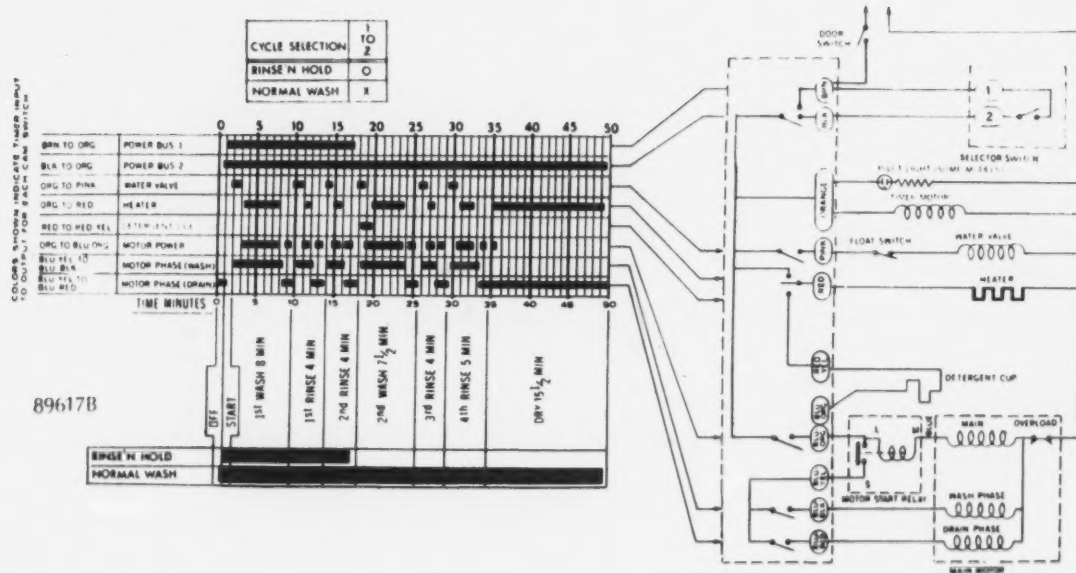
Student Supplement 1—Automatic Dishwasher Components



Automatic Dishwasher Unit 9

MAR-331

Student Supplement 2—Automatic Dishwasher Timer Sequence Chart



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**Automatic Dishwashers
Unit 9****Job Sheet 1—Install an Automatic Dishwasher Under a Counter**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Plumbing and electrical service checked	_____
Dishwasher installed to specifications	_____
Final checks completed	_____
Customer informed of operating and maintenance procedures	_____

A. Tools and materials

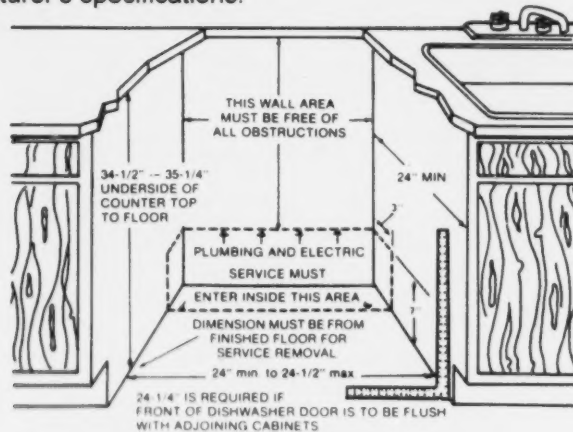
Automatic dishwasher as selected by instructor
Available cabinet enclosure rough-in
Basic hand tools
VOM
Level
Safety glasses

B. Routine 1—Check plumbing and electrical service

- ☐ 1. Make sure circuit breaker for electric service is turned off, and put on your safety glasses.

Job Sheet 1

- ☐ 2. Check enclosure distances with a tape measure to make sure they meet manufacturer's specifications.



Courtesy Frigidaire

- ☐ 3. Check to make sure that the water connection hookup is no more than 10 feet away from the dishwasher drain.

Note: Although rough-in for electric and water may have been completed by others, it is your responsibility to check each item because improper installation will void a warranty.

- ☐ 4. Check to make sure that the hot water service line is not less than 1/2" OD copper tubing or 3/8" ID NPT pipe.

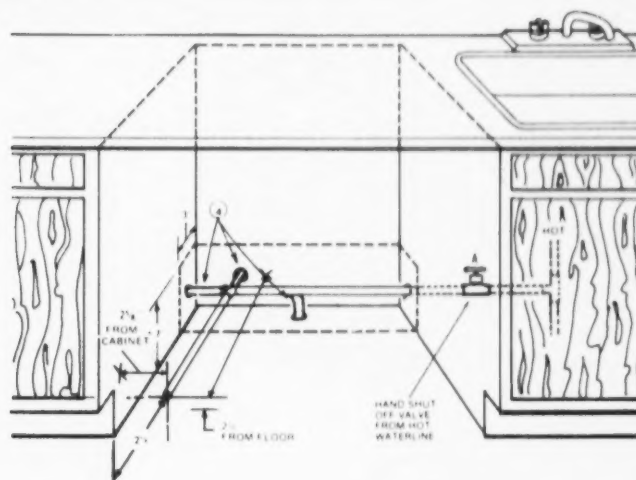
Caution: Hose of any type is not acceptable for this installation.

- ☐ 5. Make sure the hot water line has a shut-off valve that can be conveniently shut off for service or emergencies.

Job Sheet 1

- 6. Be certain the hot water supply line enters in the proper space at the back of the enclosure and that the line is 2 ½" from the floor at the point where it hooks onto the fill valve.

Note: The following illustration shows a few options that can be used for hot water supply.



Courtesy Frigidaire

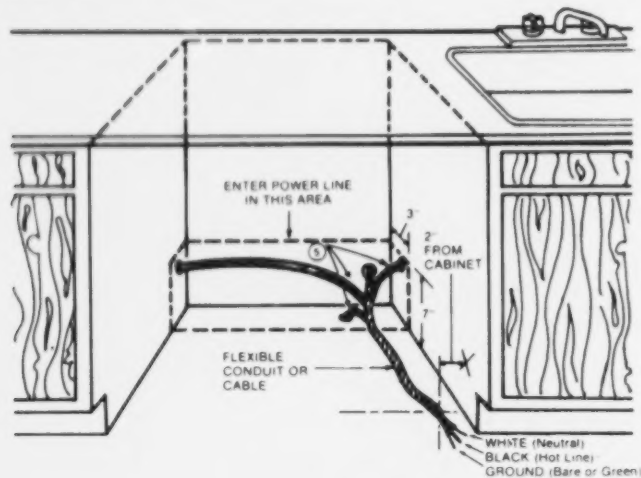
- 7. Check to see that the electrical rough-in comes in on a proper 15 amp circuit protected by a breaker device.

Note: If the same circuit will service a garbage disposer, it should be 20 amps, and in all cases, the electrical service must conform to local codes.

Job Sheet 1

- 8. Make sure the electrical service enters in the proper space at the back of the enclosure

Note: The following illustration shows some options that can be used for electrical service.

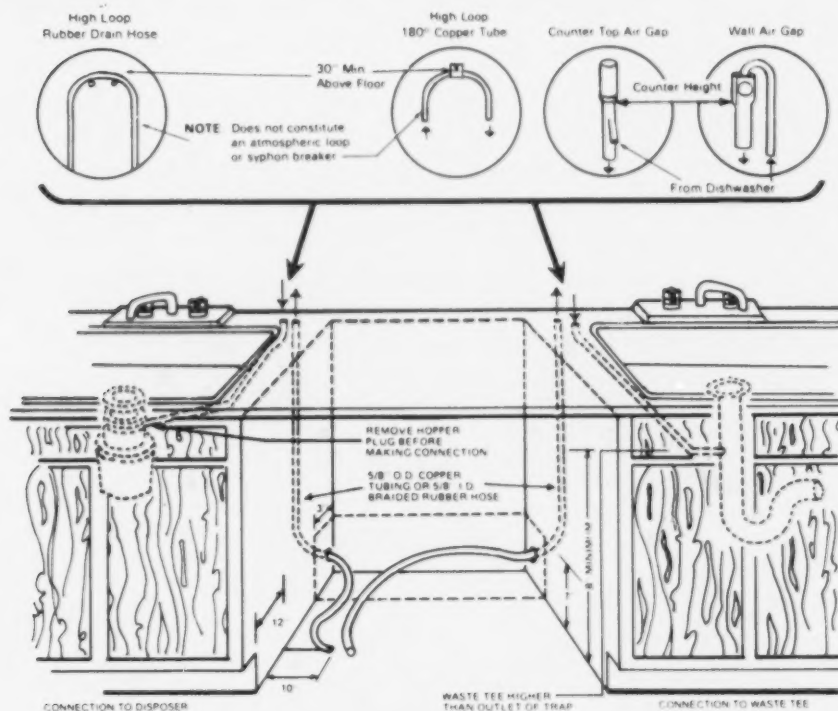


Courtesy Frigidaire

- 9. Check the rough-in drain line to the garbage disposer or to the waste tee to make sure: (See the following illustration.)
- (a) drain line is 5/8" OD copper tubing or 5/8" ID braided rubber hose,
 - (b) hopper plug has been removed from the garbage disposer for proper installation (if disposer is present), and
 - (c) drain line connection into waste tee is at least 8" off the floor (if waste tee is used).

Job Sheet 1

- ☐ 10. Make sure a high loop or an air gap is properly installed at countertop level between the dishwasher drain and the disposer or the waste tee.



Courtesy Frigidaire

Note: Air gaps are available locally and are easy to install through the sink spray hole or through a 1 1/4" hole in an adjacent counter top. The air gaps tighten down with a locknut and can be used with compression fittings or solder joints depending on local codes. An air gap made by the Frost Co. of Kenosha, Wisconsin is shown in the previous illustration.

C. Routine 2—Install a dishwasher

- ☐ 1. Use the dolly to place the dishwasher near the enclosure, and remove padding.
- ☐ 2. Remove the toe/service panel by removing the two screws at the bottom and lifting up.
- ☐ 3. Adjust leveling screws so that the dishwasher is level with the counter top.

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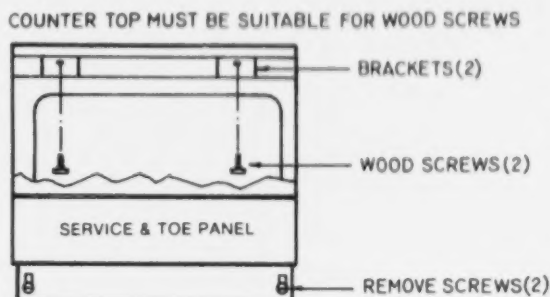
Job Sheet 1

- ☐ 4. Slide dishwasher into enclosure being careful not to hit the switch at the top of the tub.

Caution: If the screw heads on the front trim will scar the cabinets, leave the dishwasher about $\frac{1}{4}$ " out from the rest of the cabinets and make appropriate adjustments for the hot water line.

- ☐ 5. Fasten the brackets at the front of the dishwasher to the underside of the counter top with two #8 x $\frac{1}{4}$ " flat-head wood screws from the envelope that came with the dishwasher.

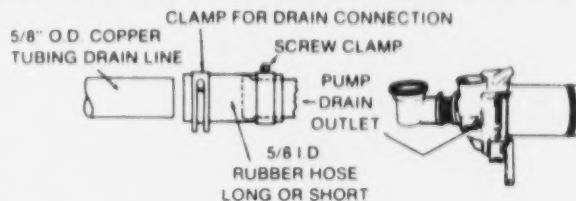
Note: The brackets may extend out a bit and require trimming.



Courtesy Frigidaire

- ☐ 6. Assemble the $\frac{5}{8}$ " OD copper tubing drain line to the pump by clamping it to the short rubber hose with clamp provided.

Note: A long or short $\frac{5}{8}$ " ID rubber hose may be used if required.



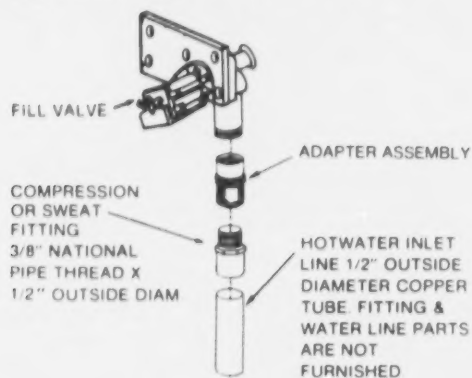
Courtesy Frigidaire

- ☐ 7. Remove the brass adapter assembly from the dishwasher fill valve.

Job Sheet 1

- ☐ 8. Assemble a $\frac{1}{2}$ " OD sweat fitting or compression fitting to the incoming hot water supply line.

Note: Soft copper may be used with compression fitting, but the chances of leaks are less if you sweat the fitting with solder, and complete any soldering before installing the adapter assembly in the next step.

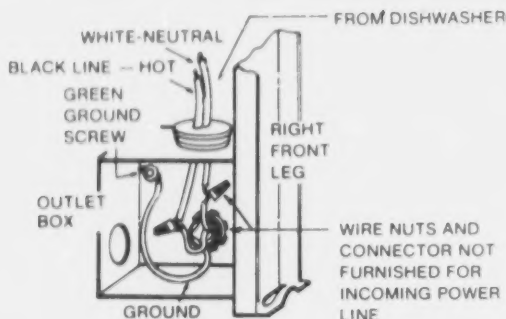


Courtesy Frigidaire

- ☐ 9. Apply pipe dope or Teflon tape to the sweat fitting threads and tighten the fitting onto the adapter assembly.
- ☐ 10. Tighten the adapter assembly to the fill valve as tight as you can get it by hand, then give it another quarter turn with a pair of pliers.
- ☐ 11. Turn on shut-off valve and check for water leaks at the adapter assembly and fill valve.
- ☐ 12. Tighten as needed and shut off water.
- ☐ 13. Double check to make sure power is shut off to the electrical supply.
- ☐ 14. Connect the incoming black wire to black wire on dishwasher.
- ☐ 15. Connect the incoming white wire to the white wire on dishwasher.

Job Sheet 1

- ☐ 16. Connect the incoming ground wire to the green ground screw.



Courtesy Frigidaire

Caution: Use UL approved wiring connectors to connect wiring, and if the connection calls for joining aluminum wiring to copper wiring, it should only be done with special materials and the work should be done by a licensed electrician.

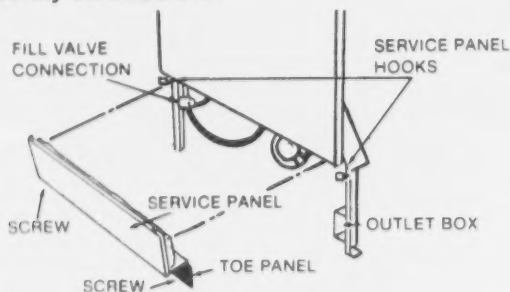
D. Routine 3—Make final checks

- ☐ 1. Check to make sure the dishwasher is properly lined up with adjacent cabinets and that the door opens and closes freely.

Note: Sometimes the counter balance springs rub against adjacent cabinets and the dishwasher still requires a clearance adjustment.

- ☐ 2. Reassemble toe/service panel by hooking the panel over the top hooks and then securing it with the two screws that were removed earlier.

Note: The toe panel provides the front cover for the electrical box, so make sure it is securely screwed on.

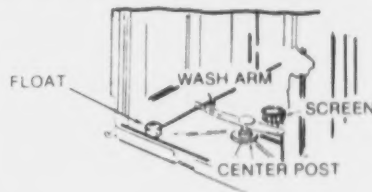


Courtesy Frigidaire

- ☐ 3. Remove all packing materials in the tub.

Job Sheet 1

- ☐ 4. Remove literature package and place it safely aside.
- ☐ 5. Check plastic screen behind center post to make sure it is firmly in place.
- ☐ 6. Place wash arm over pin in center post and turn it to make sure it has free spinning action.
- ☐ 7. Check float to make sure it is free to operate.



Courtesy Frigidaire

- ☐ 8. Check the water heater to make sure it is set no lower than 140°F and no higher than 160°F, and that it delivers minimum 140°F water to the dishwasher.
- ☐ 9. Check the dishwasher for level.
- ☐ 10. Turn on hot water supply.
- ☐ 11. Request some glasses and dishes from the customer and load them properly into the dishwasher.
- ☐ 12. Run the dishwasher through a complete cycle and watch for leaks and listen for unusual noises that might indicate a problem.
- ☐ 13. Use the time the dishwasher is completing its first complete cycle to offer the customer tips about using the dishwasher for maximum convenience and minimum trouble.
- ☐ 14. Check work order to make sure you have recorded the serial number, delivery date, and all needed warranty information.
- ☐ 15. Check dishes after first complete cycle.

Note: It is normal for a little water to be left in the tub at the end of a cycle.

- ☐ 16. Deliver the owner's manual to the customer and congratulate the customer on making an excellent dishwasher selection.
- ☐ 17. Clean up area as required and be on your way.

Job Sheet 1

- ☐ 18. Have your instructor check your work.

Comments: _____

**Automatic Dishwashers
Unit 9****Job Sheet 2—Troubleshoot Malfunctions on an Automatic Dishwasher**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Door switch continuity check correctly made	_____
Float switch continuity check correctly made	_____
Water fill valve continuity check correctly made	_____
Water fill valve filter screen cleaned	_____
Start relay continuity check correctly made	_____
Heating element continuity check correctly made	_____
Detergent dispenser continuity check correctly made	_____
Timer check complete and correct	_____

A. Tools and materials

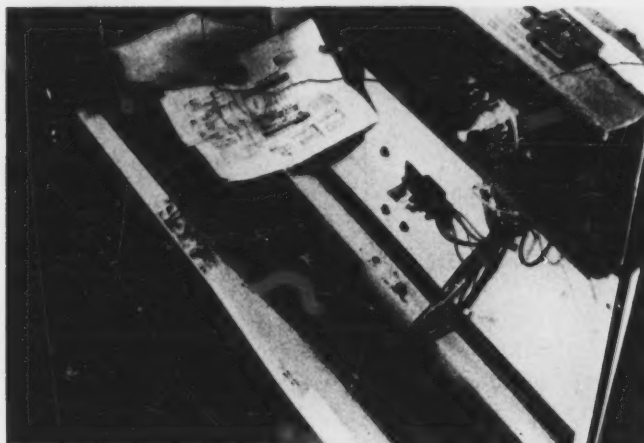
Automatic dishwasher as selected by instructor
Service manual for dishwasher
Wiring diagram and timer sequence chart for dishwasher
Basic hand tools
Motor test cord
VOM
Lint-free shop towels
Repair log (attached)
Safety glasses

B. Routine 1—Check continuity on a door switch

- ☐ 1. Sign on your repair log and put on safety glasses.
- ☐ 2. Disconnect the dishwasher from power source or trip the breaker switch.
- ☐ 3. Remove the top panel on the door.
- ☐ 4. Remove the latch handle so it can slide through the front panel opening and be removed.

Job Sheet 2

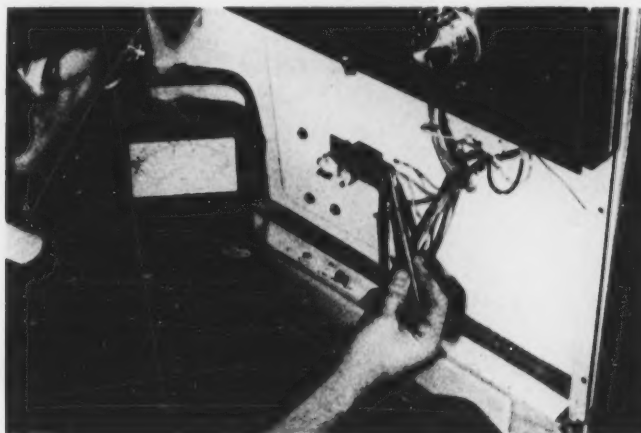
- ☐ 5. Open the door and remove the screws on either side so you can gain access to the door switch.
- ☐ 6. Check behind the panel for the wiring diagram and the timer sequence chart, and place them aside for troubleshooting reference and later replacement.



- ☐ 7. Remove the conductor lead from either door switch terminal.

Note: The door switch is wired in series with the 120V power supply so that when the door is opened all power to the unit is shut off.

- ☐ 8. Place the VOM leads in any order on the terminals of the door switch.



- (a) If there is a reading of zero when the switch is depressed to duplicate the door being locked and latched, and if there is a reading of infinity when the switch is released, the switch is okay.
- (b) Any other reading indicates the switch is bad and should be replaced.

Job Sheet 2

- ☐ 9. Record your findings, make replacement as required, and sign off repair log.
- ☐ 10. Have your instructor check your work.

C. Routine 2—Check continuity on a float switch

- ☐ 1. Sign on repair log and remove the bottom panel from the dishwasher.

Caution: Make sure power is off.

- ☐ 2. Set the VOM to R x 1.
- ☐ 3. Remove at least one conductor lead to the first switch.

Note: This is a simple off/on switch that is a water overflow protection device.

- ☐ 4. Place the VOM leads in any order on the terminals of the flat switch.
- ☐ 5. Check and record your meter reading:
 - (a) with dishwasher upright and flat in position, the reading should be zero to indicate the float switch is okay.
 - (b) if the reading is not zero, the float switch is bad and should be replaced.
- ☐ 6. Open the door, raise the float, and check your meter reading:



- (a) if the meter reading goes to infinity, the float switch is okay,
- (b) if the meter reading does not go to infinity, it means that the switch is stuck and the machine will overflow.

Job Sheet 2

- (c) if the meter reading does not go to infinity, clean the float and area around it that the float fits into.
 - ☐ 7. Open the door, raise the float, and check your meter reading again:
 - (a) if the reading is now infinity, the float switch is okay.
 - (b) if the reading is other than infinity after cleaning the float, the float switch should be replaced.
 - ☐ 8. Record your findings and sign off repair log.
 - ☐ 9. Have your instructor check your work.
- D. Routine 33—Check continuity on a water fill valve solenoid
- ☐ 1. Sign on repair log and remove the bottom panel on the dishwasher.
- Caution: Make sure the power is off.**
- ☐ 2. Set the VOM to R x 1.
 - ☐ 3. Remove at least one conductor lead to the water fill valve solenoid.
- Note: This is to eliminate the prospects that you will read back through the circuit and get an improper reading.
- ☐ 4. Place VOM leads in any order on the solenoid terminals.



- (a) if the reading is about 500 to 600 ohms, the water fill valve solenoid is okay.
- (b) if the reading is zero, the water fill valve should be replaced.

Job Sheet 2

- (c) if the reading is too high, there are bad connections within the solenoid and the water fill valve solenoid should be replaced.

Note: If another solenoid of the exact type is available, the solenoid can be replaced instead of having to replace the entire water fill valve.

- (d) if electrical checks appear to be okay but the water fill valve still does not work, go on to the next routine for cleaning the filter screen on the water fill valve.

- ☐ 5. Record your findings and sign off repair log.
- ☐ 6. Have your instructor check your work.

E. Routine 4—Clean the water fill valve filter screen

- ☐ 1. Sign on repair log and shut the water off to the dishwasher.
- ☐ 2. Disconnect the hose that feeds the water from the valve into the dishwasher.
- ☐ 3. Remove the water fill valve from its mounting and save the mounting screws.

Note: On brass body valves with tube-screen filters, the valve does not have to be removed.

- ☐ 4. Place the valve on a clean working surface.
- ☐ 5. Disconnect the 3/8" inlet water line to the valve.
- ☐ 6. Remove the flange that holds the filter screen to the plastic body.

Note: Plastic body fill valves all have filter screens like the screens in washing machine water supply lines, but sized to fit the fill valve.

Job Sheet 2

- ☐ 7. Remove the screen and clean it if it can be cleaned, or replace it if it is rusted or otherwise unserviceable.

Note: The same applies to tubescreen filters on brass body fill valves.



- ☐ 8. Secure the new filter, reassemble fill valve, and remount, if required, and sign off repair log.
 - ☐ 9. Have your instructor check your work.
- F. Routine 5—Check continuity on a start relay

- ☐ 1. Sign on repair log and remove the bottom panel on the dishwasher.

Caution: Make sure power is off.

- ☐ 2. Remove the start relay from its mounting and be sure to save the mounting screws.

Job Sheet 2

- ☐ 3. Look for the arrow on the bottom edge of the start relay and hold the relay so that the arrow points up.



- ☐ 4. Place one VOM lead on the M terminal and the other VOM lead on the L terminal of the start relay.
- ☐ 5. Check for a continuity of zero ohms.

Note: If you are using a digital VOM, you may get a reading of $\frac{1}{2}$ to 1 ohm, but this should indicate the relay is okay.

- ☐ 6. Place the VOM leads on terminals S and L of the relay.
- ☐ 7. Check to make sure there is no reading, and if there is a reading it means the plunger in the relay is stuck and the relay should be replaced.
- ☐ 8. Keep the VOM leads held securely to terminals S and L and physically turn the start relay upside down so that the arrow points downward.
- ☐ 9. Note the meter reading; it should be zero ohms.

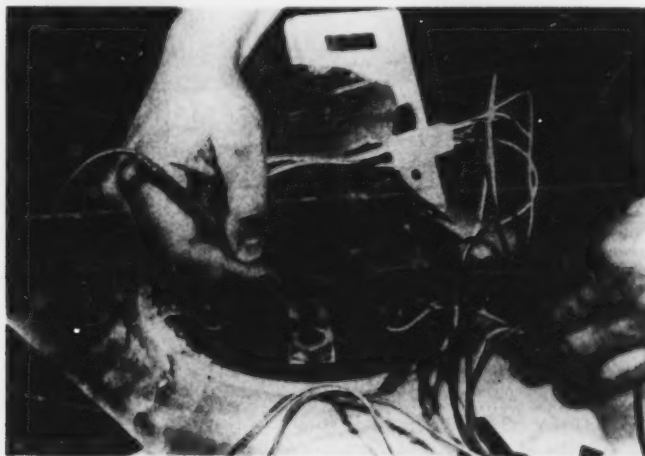
Caution: What you have just accomplished in Steps 8 and 9 is to show how the start relay is activated; if the dishwasher is started while it is on its back or side, the start relay cannot engage, improper voltage reaches the motor, and the **THE MOTOR BURNS UP**; in other words, never start an automatic dishwasher in any position other than UPRIGHT.

- ☐ 10. Record your findings and sign off repair log.
- ☐ 11. Have your instructor check your work.

Job Sheet 2

G. Routing 6—Check continuity on a heating element

- ☐ 1. Sign on repair log and set the VOM for R x 1.
- ☐ 2. Make sure power is off.
- ☐ 3. Remove the bottom panel from the dishwasher.
- ☐ 4. Remove either lead (red or white) from the heater unit.
- ☐ 5. Place one VOM lead on each of the terminals to the heater element.



- ☐ 6. Record the reading.

Note: Reading should be in the range of 10 to 20 ohms; check with your instructor if it is different.
- ☐ 7. Remove one VOM lead from either heater element terminals and place the VOM lead on any green ground wire.

Note: This will let you know if the heating element is shorted to the cabinet.
- ☐ 8. Check for a reading of infinity on the VOM, and if the reading is other than infinity, the heating element is bad and should be replaced.
- ☐ 9. Switch VOM/terminal leads and make the ground check on the opposite terminal.
- ☐ 10. Check for a reading of zero on the VOM, and if the reading is other than zero, the heating element is bad and should be replaced.
- ☐ 11. Record your findings and sign off repair log.
- ☐ 12. Have your instructor check your work.

Job Sheet 2

H. Routine 7—Check continuity on detergent dispenser

- ☐ 1. Sign on repair log and remove the bottom front panel on the dishwasher.

Caution: Make sure power is off.

- ☐ 2. Remove at least one lead from the dispenser solenoid.

Note: Some detergent dispensers are spring-loaded, solenoid-actuated components which in turn are actuated by a signal from the timer, so essentially, the problem is either with the solenoid or the spring.

- ☐ 3. Place the VOM leads in any order on the terminals of the solenoid:



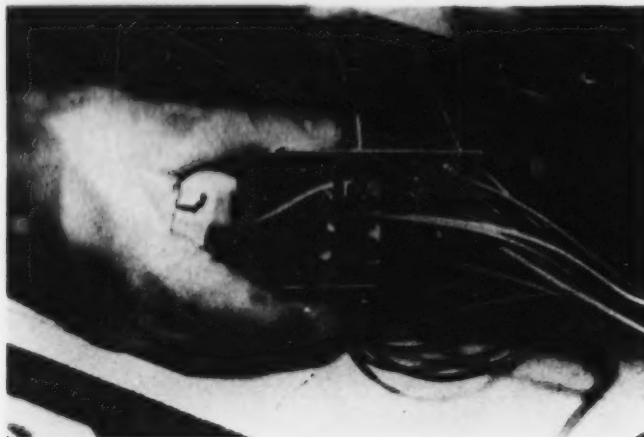
- (a) if there is a reading of 500 to 600 ohms, the solenoid is okay and the spring-loaded mechanism needs to be checked and cleaned.
 - (b) calcium deposits build up so heavily on the spring mechanism that a knife or screwdriver blade may have to be used to clean them off.
 - (c) if the solenoid reading is too high or too low, replace the solenoid.
- ☐ 4. Record your findings and sign off repair log.
- ☐ 5. Have your instructor check your work

Job Sheet 2

I. Routine 8—Check a dishwasher timer

Note: Timers on automatic dishwashers are mostly sealed units that simply have to be replaced if they are not advancing properly, but the following routine will be helpful if a timer is misaligned or a timer motor is burned out; a disconnect timer would be an exception to this routine.

- ☐ 1. Sign on repair log, make sure power is off, and remove the timer from the control panel.
- ☐ 2. Make a diagram of all conductor/terminal connections before removing any wires.
- ☐ 3. Remove conductors from timer with care because the terminals break easily.
- ☐ 4. Make a visual inspection of the timer terminal board to see if any terminals indicate charring that would indicate a short has destroyed internal connections:

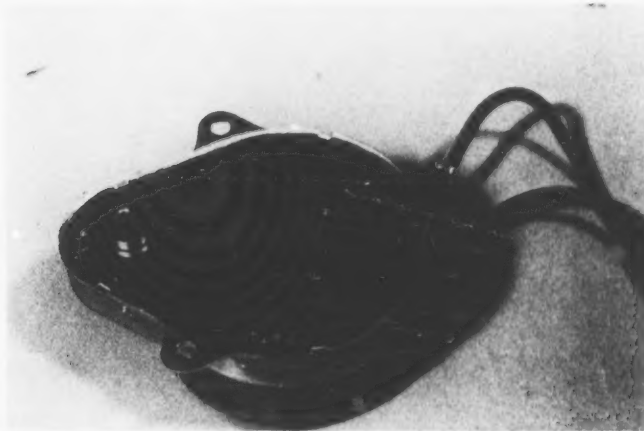


- (c) if the terminal board is burned, the timer will have to be replaced
 - (b) if the terminal board is okay, then the timer sequences chart should be checked and all timer functions should be traced and checked with a VOM.
- ☐ 6. Remove the motor assembly and disconnect the two leads from the terminal block that lead to the motor.
 - ☐ 7. Remove the motor, place it on a flat surface, and hook up a test cord for power.

Job Sheet 2

- ☐ 8. Mark a point on the motor gear and a point on the motor housing to use as a reference.

Note: A timer runs so slowly that it cannot be timed by looking at it.



- ☐ 9. Permit the motor to run ten or fifteen minutes.
- ☐ 10. Determine whether or not the motor has moved a significant distance:
- (a) if the motor has not moved, replace it.
 - (b) if the motor has moved, the motor is probably okay and the problem is in the timer itself, and the timer should be replaced.
- ☐ 11. Inspect the gears for evidence that a ring has worn around the drive gear on the motor shaft, and if so, replace the motor.
- ☐ 12. Record your findings.
- ☐ 13. Have your instructor check your work.
- ☐ 14. Sign off your repair log and make a note of any problems you had with the routines in this job sheet.
- ☐ 15. Clean up area and return tools and materials to proper storage, or prepare for next job sheet as directed by your instructor.

Automatic Dishwashers Unit 9

Job Sheet 2

Repair Log

Your name _____ Date _____

	Date	Time On	Time Off
Routine 1—Check continuity on a door switch			
Routine 2—Check continuity on a float switch			
Routine 3—Check continuity on a water fill valve solenoid			
Routine 4—Clean the water fill valve filter screen			
Routine 5—Check continuity on a start relay			
Routine 6—Check continuity on a heating element			
Routine 7—Check continuity on a detergent dispenser			
Routine 8—Check a dishwasher timer			

Note any special problems you encountered in any of your troubleshooting routines:

**Automatic Dishwashers
Unit 9****Job Sheet 3—Inspect the Seal on an Automatic Dishwasher**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Spray arm, diffuser, and impeller correctly removed	_____
Pump and plate removed for inspection	_____
Lower seal inspected, evaluated, and replaced as needed	_____
Components reassembled in correct order	_____

A. Tools and materials

Automatic dishwasher manufactured by D&M
Service manual for dishwasher
Replacement seal kit as required
Basic hand tools
Clean shop towels
Repair log (attached)
Safety glasses

B. Procedure

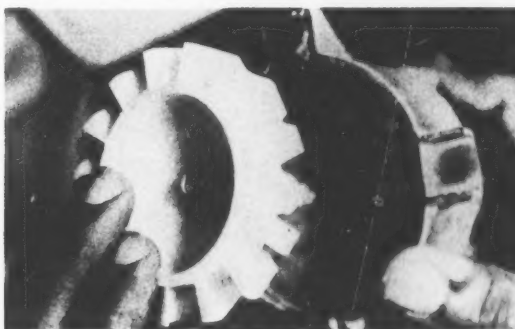
- ☐ 1. Put on your safety glasses.
- ☐ 2. Sign on your repair log.
- ☐ 3. Make sure the dishwasher is unplugged from its power source.
- ☐ 4. Wipe the seal area dry with a clean shop towel.

Job Sheet 3

- ☐ 5. Remove the nut that secures the spray arm to the diffuser housing.



- ☐ 6. Remove the nut and washer that hold the housing over the diffuser; then remove the housing and inspect the diffuser for chipped or broken vanes.

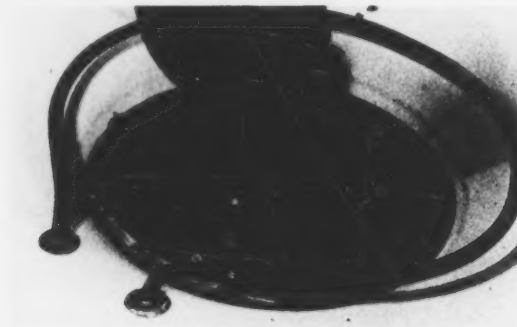


- ☐ 7. Remove the upper impeller and inspect the O-ring that seals the impeller to its shaft, and replace the O-ring if it is bad.



Job Sheet 3

- ☐ 8. Remove the two remaining screws holding the pump plate in place, and then remove the pump plate and blade.



- ☐ 9. Remove the lower impeller and inspect it for chipped or broken vanes.

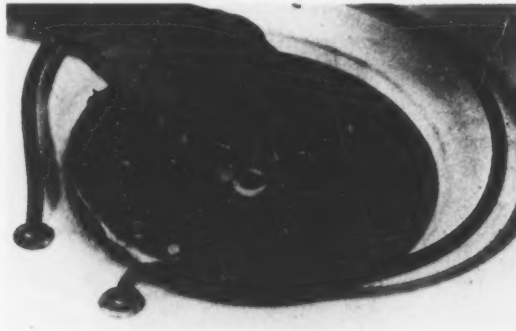


- ☐ 10. Remove the lower seal and shim from off the motor shaft. This may require working it out with the blade of a screwdriver.



Job Sheet 3

- ☐ 11. Inspect the shim on top of the seal and replace if it is worn or cracked.



- ☐ 12. Inspect the lower seal that fits around the motor shaft, and replace it if it shows any signs of wear at all because this is the seal that keeps water from flowing down onto the motor.



- ☐ 13. Have your instructor check your work.
- ☐ 14. Reassemble the seal by reversing the disassembly procedure. Replace the spray arm.



Job Sheet 3

- ☐ 15. Attach water hoses as required, plug the dishwasher in, and run it through a complete cycle as you check for leaks.
- ☐ 16. Have your instructor check your work.
- ☐ 17. Sign off your repair log.
- ☐ 18. Clean up area and return tools and equipment to proper storage.

**Automatic Dishwashers
Unit 9****Job Sheet 3****Repair Log**

Your name _____ Date _____

Brand name of dishwasher _____

	Date	Time On	Time Off
Routine 1—Condition of upper diffuser			
Routine 2—Condition of impeller O-ring			
Routine 3—Condition of lower impeller			
Routine 4—Condition of shim			

Note any special problems you encountered in any of your troubleshooting routines:

Garbage Disposers

Unit 10

Objective Sheet



Unit Objective

After completing this unit, the student should be able to install a garbage disposer and free a jammed garbage disposer. The student should demonstrate these competencies by completing the activities in the job sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to garbage disposers with their correct definitions.
2. Complete statements about first considerations for garbage disposers.
3. Complete a list of safety rules for disposer operation.
4. Match major components of a disposer with their functions.
5. Arrange in order the steps in garbage disposer operation.
6. Complete statements about the importance of cold water flow in a disposer.
7. Complete a list of common misuses that cause disposer problems.
8. Select true statements about items that can be placed into a garbage disposal.
9. Complete statements about guidelines for handling a jammed garbage disposer.
10. Select true statements about guidelines for installing a garbage disposer.
11. Complete statements about guidelines for troubleshooting disposer malfunctions.
12. Install a garbage disposal. (Job Sheet 1)
13. Free a jammed garbage disposal. (Job Sheet 2)

Garbage Disposers Unit 10

Information Sheet

1. Terms and definitions

- a. **Batch feed**—A disposer type that uses a lid that locks in place to start the motor or unlocks to stop the motor so that waste cannot be fed into the disposer while it is running

- b. **Biodegradable**—That which can be readily decomposed through natural biological processes

Example: Because biodegradable detergents can be broken down through bacterial action, they are safe for septic systems.

- c. **Continuous feed**—A disposer type that uses an ON/OFF switch and appropriate safeguards so that waste can be fed into the disposer while it is running

- d. **Local codes**—Legal guidelines for electrical and plumbing installations in a specific town, city, or designated area where local geography may impose special needs on such installations

Example: In high risk earthquake zones, all kinds of transport lines must be buried in sand, and in cold climates, water line must be buried below the frost line.

- e. **Septic tank**—A holding facility for waste matter that is directed into lateral pipes placed in a sand/gravel bed to accomplish waste disposal in areas where waste cannot be fed into a sewer line

- f. **Trap**—That part of a drain pipe so shaped that water will stand in it to help seal off offensive odors that could otherwise return from a sewer or septic system

Example: U-traps, S-traps, and P-traps are all plumbing devices that hold standing water and get their names from their shapes.

2. First considerations for garbage disposers

- a. Automatic garbage disposers and automatic dishwashers are the two appliances most subject to failure because of improper use or outright abuse by their operators.

- b. Customers having a new disposer installed should be carefully instructed in its proper use and the dangers improper use can pose to both the equipment and the customer.

3. Safety rules for disposer operation

- a. NEVER place your bare hand into a garbage disposal even when the disposer is disconnected.
- b. ALWAYS run cold water when the disposer is operating.

Note: Cold water is vital for clearing the impeller and cutters of food particles that may clog the disposer itself or the drain line.

- c. NEVER use any kind of silverware to attempt to unjam a clogged garbage disposer.

4. Major components of a garbage disposer and their functions

- a. **Lower housing**—Contains the drive motor, the stationary shredding ring, and the flywheel
- b. **Upper housing**—Contains the starting controls, the impeller, and serves as the hopper into which wastes are placed
- c. **Drive motor**—The principle part of the disposer that provides the high torque required to drive the impeller
- d. **Flywheel**—A circular device driven by the motor shaft to provide inertia and to compensate for fluctuations in operating speeds
- e. **Shredding ring**—A stationary device circling the interior of the housing and so positioned that the impeller forces waste matter against its cutting edges

Note: Cutters on a shredding ring are sometimes called vanes because of their shape or spurs because of the gouging action they cause.

- f. **Impeller**—A rotating disk with projections that force waste against the shredding ring
- g. **Mounting flange**—The top lip of a disposer that is secured over a gasket and tightened to a support ring so that the disposer can be easily installed in a kitchen sink

Note: The mounting flange is an easy installation feature that makes garbage disposers attractive appliances because modification to an existing sink is seldom required.

Information Sheet

- h. **Tailpiece**—The drain outlet of the disposer that permits easy hookup to existing plumbing with a slip-joint plumbing connection

Note: Another attractive aspect of garbage disposers is that they seldom require modification of existing plumbing.

- i. **Insulation**—Surrounds lower housing and helps to keep down the noise of the motor and grinding sounds

5. **Steps in garbage disposer operation**

- a. Garbage is placed into the disposer.
- b. The cold water is turned on.
- c. The disposer cover is put in place and turned clockwise to activate the starting control switch, if it is a batch feed model.
- d. The drive motor starts rotating.
- e. Centrifugal force impels garbage outward from the rotating flywheel.
- f. Garbage is shredded into small pieces as it is forced into the cutting edges of the shredding ring by the action of the impeller.
- g. The shredded garbage is washed down through holes in the flywheel strainer plate and on out into the plumbing drain.

Note: A few models have a cold-water interlock that prevents the motor from starting unless there is a sufficient supply of cold water flowing into the disposer; this is usually an electrical connection on the cold water line just before the cold water faucet.

6. **Importance of cold water flow in a disposer**

- a. Cold water is required as a transporting agent to carry ground-up waste away.
- b. Cold water is required to solidify grease that may be placed into the disposer so that grease can be shredded and washed away like other waste.

Note: When hot grease is washed down a drain, it almost always solidifies quickly in cold water and will eventually clog a drain.

- c. Cold water also cools the motor shaft that turns the impeller so it will not overheat.
- d. Cold water should be allowed to continue to flow about 30 seconds after all waste has been completely shredded so that the drain line will be completely flushed of waste.

7. Common misuses that cause disposer problems

- a. Overloading with waste is probably the biggest cause of disposer problems.
- b. Failure to run sufficient water during disposer operation is probably the second biggest cause of disposer problems.

Note: These two items should be emphasized when instructing a customer about proper disposer use.
- c. Injecting inorganic materials such as glass or metallic items such as silverware cause a disposer to jam and lead to other major problems.
- d. Cloth, paper, and even string can cause a disposer to jam and lead to other major problems
- e. Chemicals used to clean clogged drains should never be placed in a disposer because they will damage rubber and fiber seals and corrode metal parts.

8. Items that can be placed into a garbage disposer

- a. Waste vegetables and meat scraps
- b. Waste scraps of bread, potato and fruit peelings, and fruit seeds
- c. Bones of all sizes

Note: Sticking part of a large bone into a disposer in hopes that it will shred it up a little at a time is dangerous to the equipment and the user.

- d. Waste grease and fats

Note: Hot grease or fat should never be placed in a disposer because it may later clog up the plumbing line when it resolidifies; the cold water running into a disposer actually solidifies grease so it can be cut just like other waste and that is one reason a disposer requires cold instead of hot water.

- e. All other soluble food wastes

9. Guidelines for handling a jammed garbage disposer

- a. The most common problem with garbage disposers is that they get jammed (clogged) with food waste and have to be unjammed.
- b. When a disposer jams, always turn the disposer off, allow the motor to cool, and then press the reset button.

Information Sheet

- c. Turn on the motor-reversing switch, if the disposer has that feature, and permit the impeller to run in reverse until it is unjammed.
- d. On models without a motor-reversing switch, turn the machine off, insert an unjamming tool, and manually turn the impeller backwards.

Note: Check the owner's manual for proper use of the "unjamming tool," and if there is no tool, use a broom handle, a long-bladed screwdriver, or a T-handle wrench.

- e. Attempt to run the motor forward to complete shredding of the obstacle that caused the jamming.
- f. If the obstacle jams the disposer again, turn the disposer off, repeat the procedure for freeing the impeller, but this time, reach in with a pair of tongs and remove the obstruction.

10. Guidelines for installing a garbage disposer

- a. Check the power supply to make sure it agrees with the voltage and frequency listed on the motor nameplate.

Note: Some models may have a motor-reversing switch, but this is wired at the factory and requires no special attention at installation.

- b. Make sure the disposer is properly grounded.
- c. Existing plumbing should be carefully examined to make sure it is suitable for installation, and make sure local codes do not prohibit a disposer installation.

Note: In areas where there are drainage problems, disposers may be prohibited.

- d. The disposer should be hooked up to its own trap and not to a trap that serves another piece of equipment such as a washing machine.
- e. Unless codes require them, remove old grease traps, and if they are required, advise the customer to clean the trap every 90 days.
- f. Septic systems must have a minimum capacity of 500 gallons before a garbage disposer can function properly.

Note: An old rule of thumb is that 500 gallons will serve a two-bedroom home and that 250 gallons should be added for each additional bedroom, but in all cases, local codes dictate whether or not a garbage disposer can be used with a septic system.

Information Sheet

- g. Encourage customers with septic systems to avoid placing anything into the disposer that is not biodegradable.

Note: This includes items such as oyster and clam shells, cigar and cigarette butts, and many other inorganic items that clog a septic system.

11. Guidelines for troubleshooting disposer malfunctions

- a. Always disconnect the power before inserting any kind of tool into the disposer.
- b. Check first to see that the impeller is free to turn and unjam it if it is obstructed.

Note: If the impeller will not turn, the motor will not start.
- c. Permit the motor to cool off if it has been running and then push the reset button.

Note: On models with automatic resets, the reset will activate only after the motor cools off.
- d. Make sure a proper 120V power supply is reaching the motor because low line voltage will cause a motor to overheat and stop.
- e. Check for a blown fuse.
- f. Check for loose wires at terminals.
- g. If all else seems to be in order, check all switches by disconnecting the power supply and making continuity checks.
- h. If switches appear to be okay, the motor itself will have to be checked.
- i. Continue with troubleshooting as the problem demands.
- j. Make sure the power supply and disposer are safely grounded.

**Garbage Disposers
Unit 10****Job Sheet 1—Install a Garbage Disposer to Manufacturer's Specifications**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Sink and drain lines correctly prepared	_____
Sink mounting assembly correctly installed	_____
Disposer attached to sink correctly	_____
Plumbing connections made to local codes and correct	_____
Disposer/dishwasher connection correctly made	_____
Disposer electrical connections safely and correctly made	_____
Initial test run made and successfully completed	_____

A. Tools and materials

Garbage disposer as selected by instructor
Installation and User Guides
Sink w/electrical supply
Basic hand tools
Oil-base putty and putty knife
Plumbing router for cleaning lines
Clean shop towels
Trash bag
Safety glasses

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B. Routine 1—Prepare sink and drain lines

- ☐ 1. Put on safety glasses.
- ☐ 2. Remove sink fittings, trap, and drain line from old sink as required.

Job Sheet 1

- ☐ 3. Clean off old putty, caulking, or gasket material from the bottom and top of the sink drain hole.
- ☐ 4. Place trash into a garbage bag and keep the area as clean as possible as you work.
- ☐ 5. Clean the old kitchen drains thoroughly with a flexible plumber's cleaning router.

Note: In a new home, this step is not required, but older drain lines are usually coated with hardened grease that will retard the flow of food waste; once the old lines have been cleaned, granulated food waste from the disposer will keep them clean in the future.

- ☐ 6. Remove all written materials attached to the disposer and any special tools that come with the disposer.

C. Routine 2—Install the sink mounting assembly

- ☐ 1. Remove the sink mounting assembly from the disposer by turning the mounting lugs to the left.



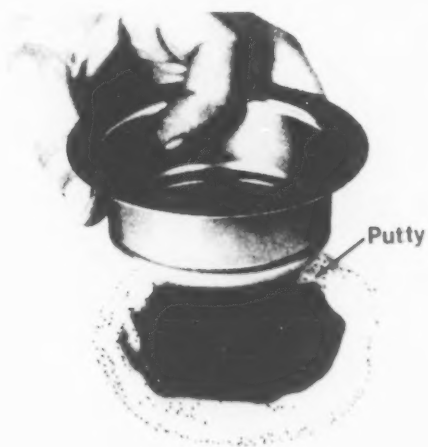
- ☐ 2. Unscrew the mounting screws on the mounting ring surface.
- ☐ 3. Take a good look at the entire sink mounting assembly so you will know how it should look when it is back together. Then pry out the snap ring holding the sink sleeve.

Job Sheet 1

- ☐ 4. Separate all the parts and lay them aside.



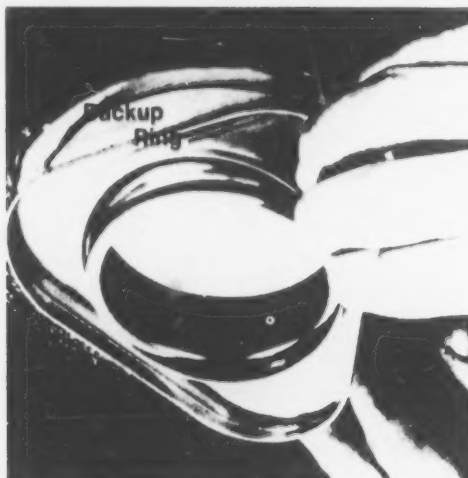
- ☐ 5. Use the putty knife to apply a liberal amount of oil-base putty around the top of the sink drain opening.



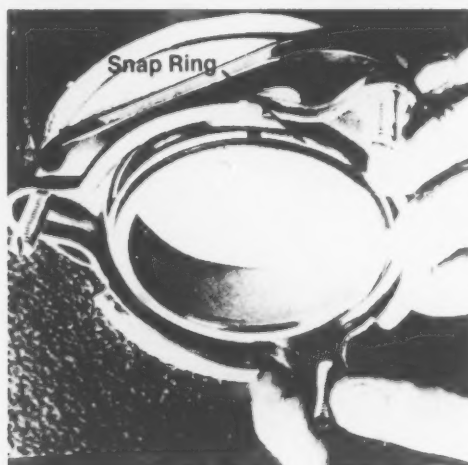
- ☐ 6. Place the sink sleeve into the sink drain opening.
- ☐ 7. Get underneath the sink and place the fiber sleeve gasket over the sink sleeve.

Job Sheet 1

- ☐ 8. Install the back-up ring flat side up.

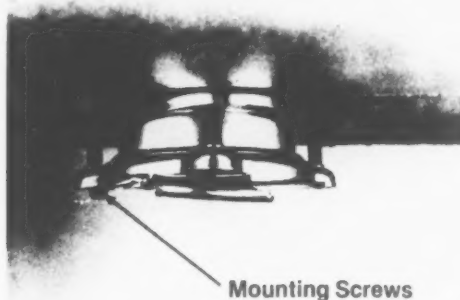


- ☐ 9. Take the mounting ring that contains the three screws and slip it onto the sink sleeve, and slide all the parts above the groove in the sleeve.
- ☐ 10. Insert the snap ring into the groove in the sleeve.



Job Sheet 1

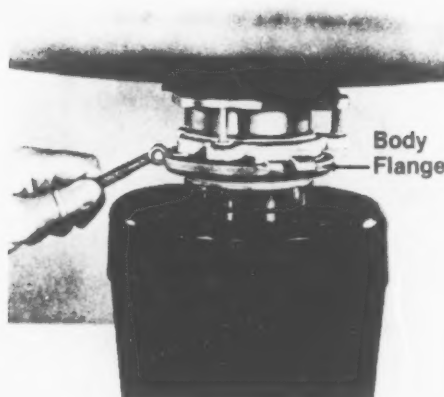
- ☐ 11. Tighten the three mounting screws evenly, and make sure they all fit into the back-up ring.
- ☐ 12. Tighten the three mounting screws until the fiber sleeve gasket and back-up ring draw up tightly against the sink.



- ☐ 13. Check your work (or have your instructor check your work) to make sure the sink mounting assembly is properly installed.

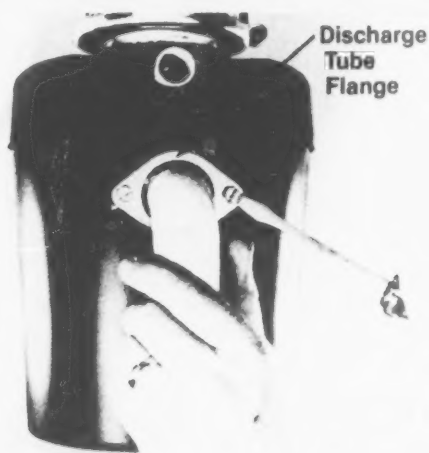
D. Routine 3—Attach the disposer to the sink

- ☐ 1. Raise the disposer up to the sink mounting assembly so that the mounting lugs on the flange of the disposer are positioned to the right of the mounting screws on the mounting ring.
- ☐ 2. Hold unit tightly in place and turn the body flange to the right until the three tabs on the body are engaged in the mounting assembly and the unit becomes self-supported.

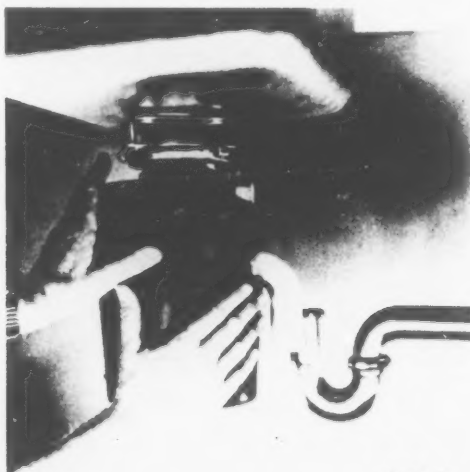


Job Sheet 1

- ☐ 3. Tighten the body onto the mounting assembly, but do not tighten securely at this time.
 - ☐ 4. Check your work (or have your instructor check your work) to make sure the body of the disposer is properly installed on the mounting flange.
- E. Routing 4—Make the plumbing connections
- ☐ 1. Install the discharge tube gasket into the disposer waste outlet opening.
 - ☐ 2. Place the discharge tube flange over the discharge tube and secure the tube in place over the tube gasket with two flange screws.



- ☐ 3. Rotate the disposer as required to align the discharge tube with the trap.
- ☐ 4. Tighten the slip nut on the trap for connection to the discharge tube and secure the tube to the trap.



Job Sheet 1

- ☐ 5. Insert the special wrench or screwdriver from the LEFT side into a mounting lug.
- ☐ 6. Turn the body flange right until all three locking tabs pass over the three lock ridges into position.



- ☐ 7. Place the stopper in the "seal" position and fill the sink with water.
- ☐ 8. Remove the stopper and permit water to flow as you check for leaks.
- ☐ 9. Check your work (or have your instructor check your work) and correct leaks as required.

F. Routine 5—Make a disposer/dishwasher connection

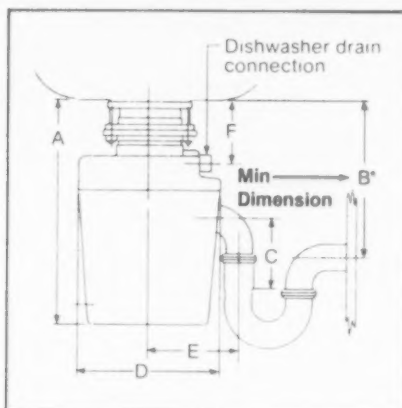
- ☐ 1. Remove the knockout plug in the dishwasher inlet by inserting a cold chisel into the dishwasher inlet at an angle, but do not center the chisel.
- ☐ 2. Tap the chisel sharply with a hammer to remove the knock-out plug.
- ☐ 3. Reach inside with tongs and remove the knock-out plug from the disposer.
- ☐ 4. Make all connections to comply with local plumbing codes.

Note: Generally, flexible connections from the dishwasher into a counter-level air gap and then down to the disposer dishwasher inlet are acceptable, but in all cases, the installation must meet local codes which may require compression fittings or soldered joints.

Job Sheet 1

- ☐ 5. Use a dishwasher connector kit if one is available, and keep all trap connections to manufacturer's specifications.

Note: Connector kits for the Frigidaire food waste disposer are available from a Frigidaire dealer or an authorized Frigidaire service center.



- ☐ 6. Check your work (or have your instructor check your work) to see that all fittings are tight.
- G. Routine 6—Make disposer electrical connections

- ☐ 1. Turn the OFF-ON switch to the OFF position, and disconnect electric power at the breaker box or remove the fuse before starting this routine.

Note: This routine assumes that electrical connections are already present, and if the connections are not present, check with your instructor.

- ☐ 2. Remove the electrical cover from the bottom of the disposer and pull out the two electrical wires there.

Job Sheet 1

- ☐ 3. Install an appropriate electrical connector in the opening on the bottom of the unit, and secure the connector with a lock nut.

Note: The installation can use BX, Greenfield, or a Romex connector.

- ☐ 4. Insert the three-wire lead into the connector and tighten the clamp.
- ☐ 5. Connect the ground wire to the grounding screw on the disposer.

Caution: Grounding properly is extremely important for a disposer, so make sure the disposer is properly connected to a grounded, metal, permanent wiring system; if needed, an equipment-grounding conductor must be run with the circuit conductor and connected to the grounding terminal lead on the disposer.

- ☐ 6. Connect the white wire from the disposer to the neutral wire of the power supply.
- ☐ 7. Connect the black wire from the disposer to the black wire of the power supply.
- ☐ 8. Plug cord-connected disposer, if it is one, into a properly grounded receptacle designed for a three-prong plug.
- ☐ 9. Replace the electrical cover on the bottom of the disposer.
- ☐ 10. Check all connections (or have your instructor check them).

H. Routing 7—Make an initial test run

- ☐ 1. Remove the drain cover from the disposer and turn on a medium flow of cold water and leave the water on during the entire disposer operation.
- ☐ 2. Check for leaks once again.
- ☐ 3. Turn the breaker on or replace fuse as required to start the disposer, then turn the wall switch ON.
- ☐ 4. Feed food waste into the disposer while it is operating.
- ☐ 5. Permit disposer to operate until waste has been properly ground up (you can tell by the sound), and then let the disposer continue to run with cold water running for about another 30 seconds so all waste will be completely flushed down the drain.
- ☐ 6. Turn the wall switch OFF and turn the cold water off.
- ☐ 7. Deliver warranty and operating instructions to customer.
- ☐ 8. Explain warranty and advise customer on proper use.

Job Sheet 1

- ☐ 9. Congratulate the customer on a wise disposer selection.
- ☐ 10. Clean area as required, thank the customer, and leave on a positive note.
- ☐ 11. Have your instructor evaluate your installation.
- ☐ 12. Clean area and return tools and materials to proper storage.

Comments _____

**Garbage Disposers
Unit 10****Job Sheet 2—Free a Jammed Garbage Disposer**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Disposer electrical safely unhooked or locked out	_____
Disposer cleared of obstacles and allowed to cool	_____
Restart button pressed at correct time	_____
Disposer filled with waste and given a test run	_____

A. Tools and materials

Garbage disposer as selected by instructor
Special unjamming wrench, if available
Broom handle (optional unjamming tool)
Pair of tongs
Trash bag
Safety glasses

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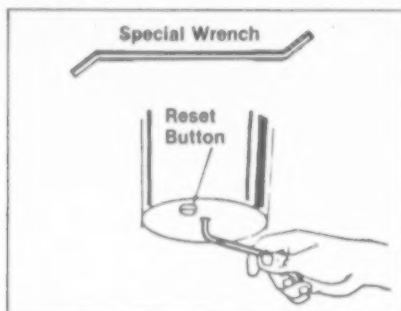
B. Procedure

- ☐ 1. Put on safety glasses
- ☐ 2. Make sure the electrical power to the disposer is turned OFF at the breaker, or remove the fuse.
- ☐ 3. Use a pair of tongs to remove as much food waste from the disposer as possible and place the waste in a trash bag or box for later disposal.

Job Sheet 2

- ☐ 4. Insert the special wrench that came with the disposer into the center hole at the bottom of the disposer.

Note: This is a special Frigidaire wrench. Other manufacturer's may supply a different type of wrench.



- ☐ 5. Work the wrench back and forth until you can turn the flywheel freely for at least one complete revolution.

Note: In case you do not have a special unjamming tool, your instructor may direct you to insert a broom handle into the top of the disposer and attempt to turn the flywheel to unjam the unit.

- ☐ 6. Use a pair of tongs to remove the foreign object that caused the disposer to jam.
- ☐ 7. Wait 5 minutes to allow the motor to cool.
- ☐ 8. Push the red restart button at the bottom of the disposer.
- ☐ 9. Turn on the cold water and restore power to the disposer.
- ☐ 10. Allow the disposer to run until it has been thoroughly flushed.
- ☐ 11. Place food waste removed in Step 2 into the disposer and allow the disposer to run until all waste has been disposed of and the disposer is thoroughly flushed.
- ☐ 12. Turn off disposer and cold water (in that order).
- ☐ 13. Have your instructor check your work.
- ☐ 14. Clean up area and return tools and materials to proper storage.

Comments _____

Trash Compactors

Unit 11

Objective Sheet



Unit Objective

After completing this unit, the student should be able to use schematics to determine operating conditions on a trash compactor, install an undercounter trash compactor to specifications, test the drive motor on a trash compactor to determine its operational condition, and troubleshoot a trash compactor for typical malfunctions. The student should demonstrate these competencies by completing the activities in the assignment and job sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to trash compactors with their correct definitions.
2. Complete statements about trash compactor characteristics.
3. Arrange in order the steps in a typical compactor cycle.
4. Match compactor electrical components with their characteristics.
5. Select true statements about trash compactor operating safety.
6. Complete statements about trash compactor service safety.
7. List guidelines for properly loading a compactor.
8. Complete statements about common causes for failure to compact.
9. Select true statements about major wear problems with compactors.
10. Complete statements about lubrication requirements for compactors.
11. Complete statements about chain and belt adjustments.
12. Match compactor problems with troubleshooting guidelines.
13. Complete statements about guidelines for troubleshooting a noisy compactor.
14. Complete statements about guidelines for troubleshooting other compactor problems.

Objective Sheet

15. Select true statements about items that should not be placed in a trash compactor.
16. Use schematics to determine operating conditions on a trash compactor. (Assignment Sheet 1)
17. Install an undercounter trash compactor to specifications. (Job Sheet 1)
18. Test the drive motor on a trash compactor to determine its operational condition. (Job Sheet 2)
19. Troubleshoot a trash compactor for typical malfunctions. (Job Sheet 3)

Trash Compactors Unit 11

Information Sheet

1. Terms and definitions

- a. **Bumpers**—Stops so placed that the ram will strike them as it nears the bottom of the trash drawer and complete a full cycle even when there is less than a minimum load of trash
- b. **Power screws**—Sprocketed rotating shafts that are chain or belt driven to build up the high torque required to power the ram
- c. **Ram**—A round or box-shaped welded steel component that is driven into the trash drawer to compact trash
- d. **Ram wiper**—A gasket-like attachment extending from all sides of the ram so that the walls of the trash drawer will be wiped clean during compaction
- e. **Trash drawer**—A welded steel drawer at the bottom of the compactor where trash bags are placed and from which full trash bags are removed

2. Trash compactor characteristics

- a. Trash compactors are designed to reduce trash to approximately one-fourth its original size and contain it in a leak resistant bag.
- b. Trash compactors also have built-in components to hold and disperse deodorant to eliminate unpleasant odors.
- c. As a safety factor, almost all trash compactors must be turned on with a key.
- d. Compactors also have built-in safety devices to protect the trash drawer from being damaged by the ram.
- e. Most trash compactors use special Kraft/polyethylene bags and substitute bags will not work properly.
- f. Compactors are built with straight rams or scissor-type rams, but both types operate with power screws and have similar service characteristics.

Information Sheet

3. Steps in a typical compactor cycle

- a. The trash drawer must be closed and the ram in home position.
- b. The key lock switch must be turned ON.
- c. The start switch must be depressed and held down until the ram travels $\frac{3}{4}$ ".
- d. The motor runs clockwise (CW) to engage the drive sprocket and chain to the power screws which in turn start the ram traveling downward.
- e. The ram will travel downward until the motor is stalled by the action of compacting trash or by striking the four bumpers located on the frame channel.
- f. The motor stall stops the clockwise motor starting switch and energizes the counterclockwise (CCW) motor starting switch.
- g. As the motor reverses, the ram travels upward until it returns to the normal OFF or home position.

4. Compactor electrical components and their functions (See Student Supplement 1)

- a. **Start switch**—Key operated so that when turned to ON it energizes the motor and starts downward ram travel

Note: The start switch must be held in position until the ram has traveled at least $\frac{3}{4}$ " downward; if it is released prior to required ram movement, the ram will stop.

- b. **Top limit and ram directional switch**—Mounted on the front frame so that it is activated by ram movement to control motor direction which in turn controls the down/up ram movement

Note: When the unit is OFF, the top limit switch is open, but when the unit is turned ON, the switch closes and causes the motor to turn in a clockwise direction to move the ram downward; when ram stops for any reason, the switch causes the motor to move counterclockwise and move the ram upward.

- c. **Drawer safety switch**—Is energized anytime the drawer is improperly loaded or improperly closed to indicate a problem
- d. **Drawer tilt switch**—Is energized anytime the load shifts forward in the drawer to stop the ram and prevent damage to both the drawer and the ram

Note: On some compactors, the drawer tilt switch is tied in with a restart light that will alert the customer to the problem.

Information Sheet

- e. **Drive motor**—Usually a 1/3 HP that operates on 120V AC at 60 Hz

Note: Technically, drive motors are split phase, four pole, reversible, open type motors with two start windings, a replaceable starting switch, and a nonreplaceable motor protector.

5. **Trash compactor operating safety**

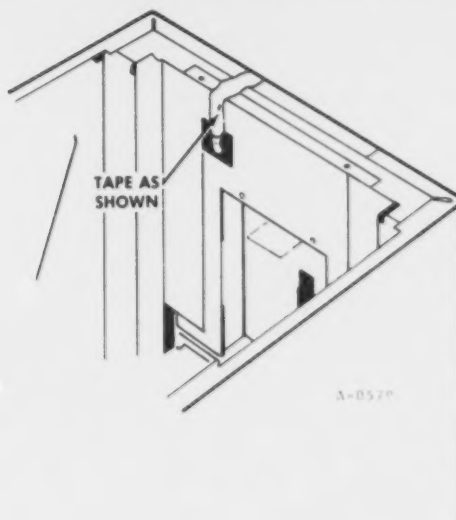
- a. All trash compactors should be properly grounded at the time of installation and checked for proper grounding after any repairs.
- b. Children should never be allowed to operate a trash compactor or load or unload a bag in the trash drawer.
- c. Always wear gloves when unloading a trash bag because fragments of glass may be sticking through the bag.
- d. Clean the trash drawer at regular intervals to keep down odors and maintain a sanitary appliance.
- e. Provide as much ventilation space as possible around the compactor because compactor motors get demanding service and overheat easily.
- f. Do not overload the trash drawer because the unit will not compact and it will cause excessive motor and power screw wear.
- g. NEVER place aerosol cans in a trash compactor.

6. **Trash compactor service safety**

- a. Always unplug the compactor from its power source before making electrical tests.
- b. Block the ram up to assure that it will not accidentally fall on your hand.

Information Sheet

- c. Tape the switch arms of the top limit and directional switches when removing or reinstalling the ram because the switch arms can be damaged.



- d. Never bypass or otherwise disable a safety device for any reason.
- e. Always disconnect at least one terminal lead when checking continuity on electrical switches.

Note: Leaving both terminals connected could cause you to read back through the circuit and get an improper reading.

7. Guidelines for properly loading a compactor

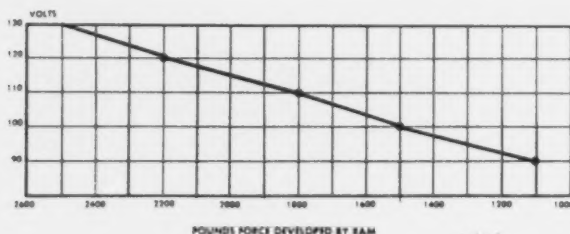
- a. Make sure the ram is in the home position.

Caution: On some models, trash can be loaded with the ram in the down position, and doing so would cause extensive damage to the switching mechanism.

- b. Place folded newspapers in the bottom of the trash drawer to help minimize tears in the bag caused by glass or metal fragments.
- c. Place paper over bottles or light bulbs to keep broken glass within the trash bag.
- d. Lay large bottles lengthwise in the center and lightly to the rear of the trash drawer.

8. Common causes for failure to compact

- a. The compact force developed by the ram is directly related to the voltage supplied to a unit while compacting action is in progress.
- b. Since force/voltage are directly related, low voltage while compacting is taking place will impair performance.



- c. Customer may be trying to compact too small a load because maximum ram travel is 5" less than the depth of the trash drawer and compaction cannot take place until drawer is at least 1/3 full.
- d. Customer may have bottles mixed in with a spongy load that prevents the bottles from breaking.

Note: Most, but not all, bottles in a load will be broken.

- e. Customer may be overloading the compactor to the point that the crushing resistance of the load is greater than the crushing force of the ram.



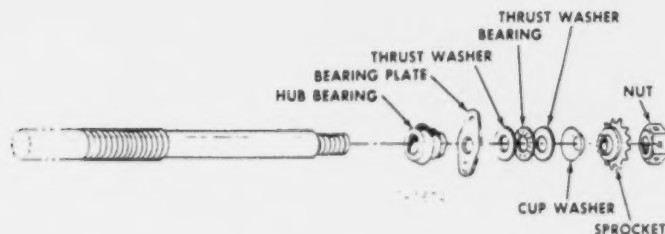
9. Major wear problems with compactors

- a. Motor burnout may be a problem with trash compactors, and it can be caused by overloading or by overheating in poorly ventilated locations.
- b. Power screws are subject to high torque stress and threads may strip.

- c. Chains and belts break or go out of adjustment because they are subject to high torque stress.
- d. Motors should be checked carefully before replacement.

Note: See Job Sheet 2.

- e. Power screws and their associated bearings, washers, sprockets, and nuts can be ordered from supply houses and replaced.



- f. Chains and belts are both replaceable or can be adjusted by loosening the motor mounting and moving the motor one way or the other.

Note: Chains go together with a master link.

10. Lubrication requirements for compactors

- a. Power screws should be lubricated with a multi-purpose molybdenum grease designed especially for high pressure applications.
- b. Slide rollers on the trash drawer should be lubricated with SAE 30W oil.

11. Chain and belt adjustments

- a. Tightening loose belts or chains is best done by loosening the motor mount screws and moving the motor as required.
- b. Chains and belts should normally have a deflection of $3/8$ " to $1/2$ " at midpoint between sprockets, but in all cases, check specifications.

Information Sheet

12. Troubleshooting guidelines for trash compactor problems**a. When the compactor will not start, troubleshoot for:**

- (1) no power to the unit (breaker or fuse, or not plugged in).
- (2) start switch not held to START, or not held in position long enough.

Note: Switch must be depressed until motor is energized and ram travels at least $\frac{3}{4}$ ".

- (3) defective start switch.
- (4) drawer not properly closed.
- (5) defective drawer safety switch.
- (6) motor protector open.
- (7) motor windings open.
- (8) top limit and ram directional switch defective.
- (9) a loose connection or a broken wire.

b. When the compactor will not stop, troubleshoot for:

- (1) a drive nut that has run off the top of the power drive screws.
- (2) top limit and ram directional switch not properly adjusted or defective.
- (3) start switch defective or momentary contact stuck closed.
- (4) stripped threads on the power drive nuts, or stripped threads on the power drive screws.

c. When the compactor stops before the end of a cycle, troubleshoot for:

- (1) top limit and ram directional switch not properly adjusted or defective.
- (2) drawer tilt switch open, usually indicated when the restart light comes on.
- (3) drawer tilt switch open because the drawer has tilted because of an unbalanced load.
- (4) motor protector open.
- (5) a loose connection or broken wire.

Information Sheet

- (6) if the problem occurs at the reversing point, troubleshoot for a defective ram directional switch, a motor start switch stuck open, or a start winding open.
- d. When the compactor reverses too soon, troubleshoot for:
 - (1) motor speed being dragged down by insufficient lubrication on power drive screws, nuts, and bearings.
 - (2) ram binding because of worn or missing glides.
 - (3) unusually dense load of too many cans or odd-shaped bottles.
 - (4) low voltage causing insufficient torque.
- e. When the drive screw runs the wrong way, troubleshoot for:
 - (1) if it begins at the start of the cycle, the top limit ram directional switch is probably bad.
 - (2) if it happens during any part of the cycle, the top limit and directional switch may be wired improperly or the start windings may be reversed on the motor.

13. Guidelines for troubleshooting a noisy compactor

- a. If the problem is at the start of the cycle and is accompanied by a thumping sound, the power drive screw nuts are probably off the top of the threads.
- b. If the noise occurs during ram travel, troubleshoot for:
 - (1) chain too tight or too loose.
 - (2) insufficient lubrication.
 - (3) worn power screw drive bearings.
 - (4) worn drive gear assembly.
 - (5) worn motor drive gear.
 - (6) worn thrust bearings.
 - (7) loose or worn power drive screw nuts.

Information Sheet

c. If the noise occurs during the bottom of the cycle, troubleshoot for:

- (1) worn bumpers.
- (2) loading down.

14. Guidelines for troubleshooting other compactor problems

a. When the complaint is unpleasant odor in or around the compactor, troubleshoot for:

- (1) garbage outside the container.
- (2) inside of drawer needs cleaning.
- (3) inside of cabinet needs cleaning.
- (4) deodorizer needs to be replaced.
- (5) garbage has been left standing too long.

b. When trash bags get tangled in the ram, troubleshoot for:

- (1) improperly installed trash bag.
- (2) wrong type of trash bag used.

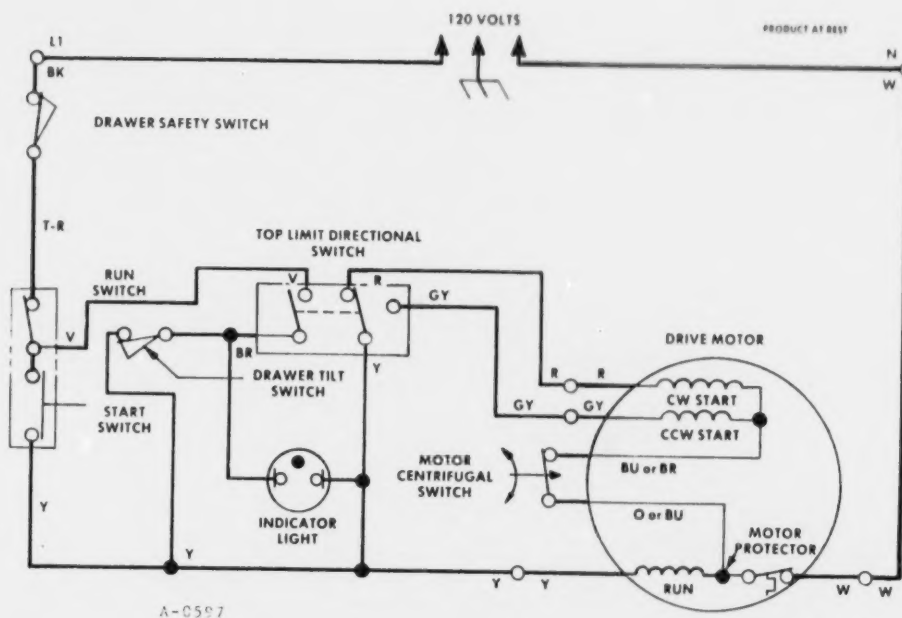
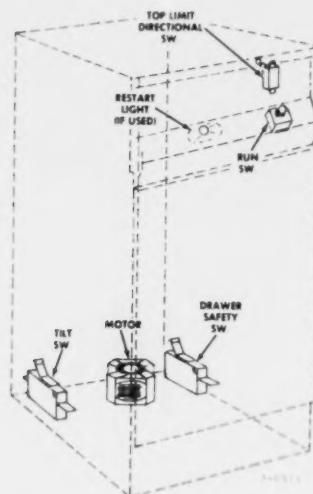
Note: Customer should always buy and use the bags recommended in the owner's or operator's guide.

15. Items that should not be placed in a trash compactor

- a. Soft food wastes should be disposed of in a garbage disposer because in a compactor they dirty the ram.
- b. Fish and meat trimmings and citrus rinds quickly build up strong odors in a compactor and are best handled in a garbage disposer.
- c. Aerosol cans should not be compacted, and especially aerosol cans that contained insecticides or any material considered toxic or hazardous.

Trash Compactors Unit 11

Student Supplement 1—Compactor Wiring Schematic



Courtesy Frigidaire

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Trash Compactors **Unit 11**

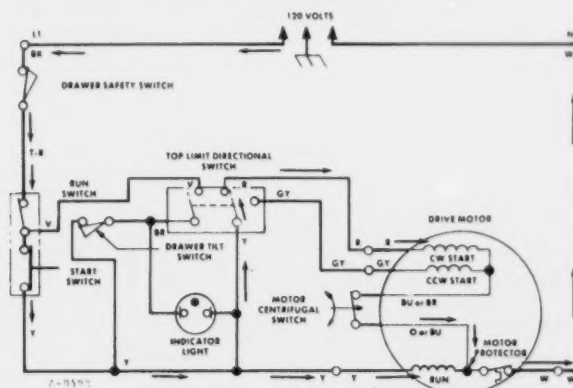
Assignment Sheet 1—Use Schematics to Determine Operating Conditions **on a Trash Compactor**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Parts A, B, and C completed	_____
Number of questions correctly answered	_____

- A. The following schematic shows a compactor just after the motor has started and the ram has traveled downward at least $\frac{3}{4}$ ". Reference the schematic to answer questions about the compactor operating conditions at that time.



- Which start windings have been energized, CW or CCW?

- The start switch was released after the ram traveled $\frac{3}{4}$ ", is the start switch now open or closed?

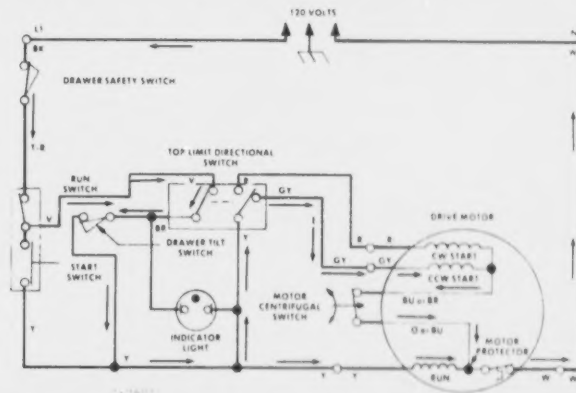
- Is the run switch open or closed at this point in the cycle?

- What is the condition of the drawer tilt switch?

Assignment Sheet 1

5. Is the indicator light ON at this point in the cycle?
-

- B. The following schematic shows a compactor at a specific point in a compacting cycle. Examine the schematic and answer the questions that follow.



1. Since the schematic indicates that the CCW start windings have been energized, what is happening at this point in the cycle?

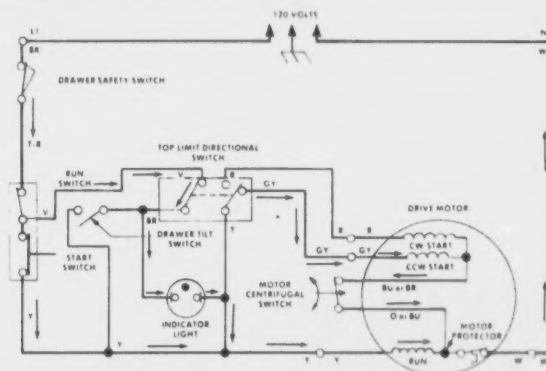
2. If the schematic indicated that the drawer tilt switch was open, would the cycle continue or stop?

3. Is the indicator light ON at this point?

4. Is there anything in the schematic to indicate there is anything wrong with the compactor at this point?

Assignment Sheet 1

- C. The following schematic shows a compactor with safety devices at work. Examine the schematic and answer the questions that follow.



1. What safety device is working and what is its condition?

2. What has happened to the indicator light?

3. What is the current condition of the compactor?

**Trash Compactors
Unit 11****Job Sheet 1—Install an Undercounter Trash Compactor to Specifications**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Electrical requirements checked out	_____
Compactor installed to specifications	_____
Operating literature delivered to customer	_____
Front panel color changed (optional)	_____

A. Tools and materials

Trash compactor as selected by instructor
Service/installation manual for compactor
Basic hand tools
VOM
Lint-free shop towels
Household cleaner
Level
Safety glasses

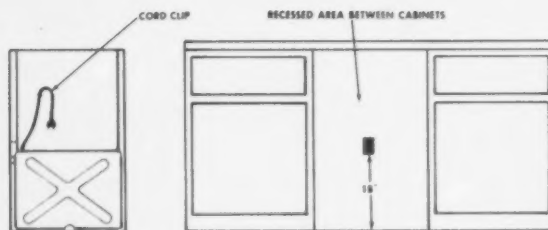
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B. Routine 1—Check out electrical requirements

- ☐ 1. Put on safety glasses.
- ☐ 2. Check the electrical service available for the trash compactor for:
 - (a) 120V 60 Hz, AC power only.
 - (b) 15 amp fused electrical supply is required with a time-delay fuse or a circuit breaker.
 - (c) separate circuit serving only the trash compactor is recommended.

Job Sheet 1

- ☐ 3. Check for proper electrical grounding because a trash compactor must be properly grounded:
- (a) the 3-prong power supply cord on the unit must be plugged into a mating 3-prong, grounded wall receptacle.
 - (b) grounded wall receptacle should be about 18" off the floor and about center of the recess where the compactor will be installed.



- (c) never cut the grounding prong off a plug to defeat the ground, and never use an extension cord as a power supply to the compactor.

Note: If a proper, grounded receptacle is not available, the customer should be informed that one should be installed by a licensed electrician.

C. Routine 2—Install the compactor

- ☐ 1. Remove the shipping carton and protective packaging materials such as tape and shipping pads.

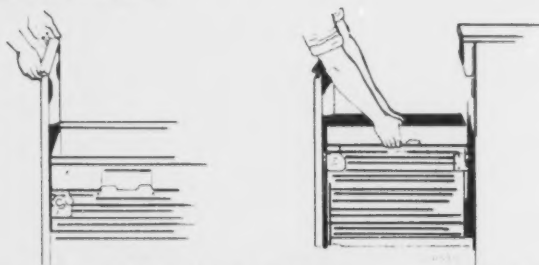
Note: Keep these materials out of the way and be sure to remove them when you leave.
- ☐ 2. Remove the package taped to the top cover; it contains the stabilizer catch and mounting catch that will be installed later.
- ☐ 3. Check compactor for any waxy residue left by protective shipping material, and if required, use household cleaner and water to clean the cabinet.
- ☐ 4. Open the drawer and remove and save the materials and literature shipped with the compactor.

Job Sheet 1

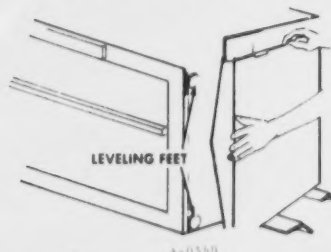
- ☐ 5. Remove the drawer as follows:

- (a) grip the handle and raise the front of the drawer until it clears the stops.
- (b) grasp the ridges of the door front and lift the drawer out.

Note: Remember the procedure for you will have to reverse it when you replace the drawer.



- ☐ 6. Lay two corner posts from the shipping carton onto the floor so positioned that the unit can rest on them without marring the cabinet finish.
- ☐ 7. Lay the unit over on one side on the corner posts.

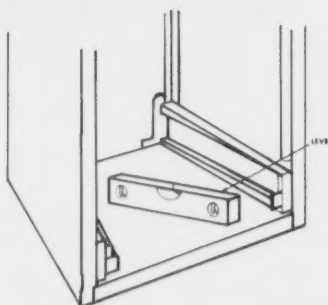


- ☐ 8. Remove the cardboard shipping pad from the bottom of the unit.
- ☐ 9. Turn all four leveling feet out the same distance so they will be preadjusted.
- ☐ 10. Stand the compactor upright with care and move it to the area in front of the recess.
- ☐ 11. Move the compactor into location, and be careful not to pinch your fingers between the adjacent cabinets.
- ☐ 12. Check the compactor for level, and make sure it is high enough that the stabilizer bracket contacts the underside of the countertop.

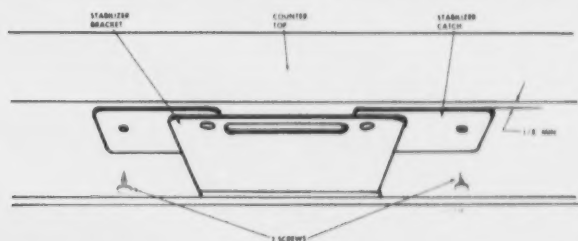
Job Sheet 1

- ☐ 13. Remove the compactor from the recess and raise the four leveling feet as required to get the compactor high enough while still keeping it level.

Caution: Use the level on the bottom panel, but be careful that the compactor does not drop on your hand.



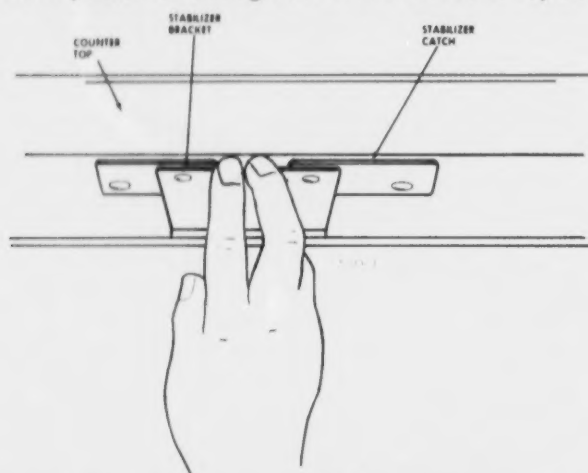
- ☐ 14. Work compactor into recess, make a final check for level, then pull the compactor out far enough to plug the power cord into the grounded receptacle at the back of the recess.
- ☐ 15. Work the compactor back into place and flex the stabilizer bracket downward so that the stabilizer catch will slide over it and the parts will latch together.



- ☐ 16. Make sure there is at least 1/8" between the front edge of the countertop and the front edge of the stabilizer bracket, and, if necessary, move the compactor back until the 1/8" clearance is attained.
- ☐ 17. Screw the stabilizer catch securely to the underside of the countertop with the screws that came with it.

Job Sheet 1

- ☐ 18. Use your fingers to release the stabilizer bracket from the stabilizer catch and pull the compactor far enough out of the recess to replace the drawer.



- ☐ 19. Replace the drawer by grasping the side ridges and placing it onto the tracks while being careful to lift so the front will clear the stops.
- ☐ 20. Close the door, and note that the flexible vinyl toe panel returns to its original shape as the drawer is replaced.
- ☐ 21. Work compactor into recess, and if the toe plate should rub the floor at the front of the compactor, trim it in the following manner:
- (a) measure the amount that will need to be trimmed from the toe plate,
 - (b) slide the drawer from the unit, and lay the drawer so that the front panel faces upward,
 - (c) use the level as a straightedge and mark a straight line across the toe plate, and
 - (d) cut the excess toe plate off with scissors, and replace the panel and the drawer.
- ☐ 22. Deliver operator's manual, extra bag, and warranty to customer.

Caution: It is carefully outlined in the operator's manual, but remind the customer that children should never be allowed to operate the compactor and that the keys should be kept in a place where children cannot reach them.

- ☐ 23. Review safe compactor loading, operation, and maintenance with the customer.

Note: In the event the compactor has alternate color options for the front panel, and the customer wants a different color panel, go on the next routine.

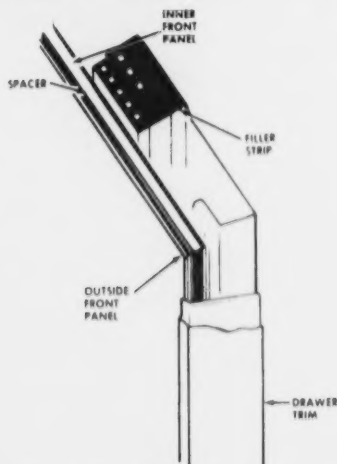
Job Sheet 1

- ☐ 24. Congratulate the customer on a wise choice of compactor, pick up left over packing materials, and be on your way.

D. Routine 3—Change front panel colors

- ☐ 1. Remove the drawer from the unit as previously outlined.
- ☐ 2. Remove the handle by removing the screws at the top inside the drawer.
- ☐ 3. Remove the corrugated filler strip from behind the front panels.
- ☐ 4. Remove only the inner front panel by carefully pulling it up between the drawer trim.

Caution: The panels have cut metal edges so handle them with care to avoid injury or damage to the panels.



- ☐ 5. Remove the spacer which fits between the panels.
- ☐ 6. Remove the outside panel by carefully pulling it up.
- ☐ 7. Remove the panel color selected by the customer and carefully place it in the front of the door trim.

Note: Typical color selections are beige, white, black, or brushed aluminum.

- ☐ 8. Replace the spacer.
- ☐ 9. Replace the other panel carefully and put the corrugated filler back in place.

Note: The flat section of the handle may be used to push the panel in the last couple of inches, but work with care.

Job Sheet 1

- ☐ 10. Replace the handle with the screws removed previously.

Caution: Never attempt to operate a compactor with the handle removed because it would be possible to accidentally enter the ram.

- ☐ 11. Slide the drawer back into the unit.
- ☐ 12. Clean up area as required and invite the customer to inspect the new color panel.
- ☐ 13. Have your instructor check your work.

Comments _____

**Trash Compactors
Unit 11****Job Sheet 2—Test the Drive Motor on a Trash Compactor
to Determine Its Operational Condition**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Motor run winding tested	_____
Motor start windings tested	_____
Centrifugal switch tested	_____
Motor clockwise/counterclockwise functions tested	_____

A. Tools and materials

Trash compactor as selected by instructor
Service/installation manual for compactor
Basic hand tools
Motor test cord
Safety glasses

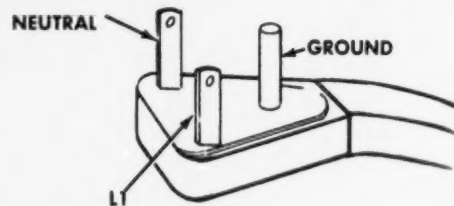
The following procedure and illustrations are adapted from materials published by Frigidaire and are reprinted with permission. Any other use is prohibited.

B. Routine 1—Test the motor run winding

- ☐ 1. Put on safety glasses.
- ☐ 2. Make sure unit is unplugged from its power supply.
- ☐ 3. Remove the Y wire from the start switch.
- ☐ 4. Remove the Y wire from the directional switch.
- ☐ 5. Set the VOM for R x 1 and zero the meter.

Job Sheet 2

- ☐ 6. Connect one test lead to the neutral side of the compactor's power cord and the other lead alternately to each Y wire.



- ☐ 7. Check meter reading and record your finding:
- (a) if each reading is 3 to 5 ohms, the motor run winding is okay.
 - (b) if the readings are other than 3 to 5 ohms, continue with other tests.
- ☐ 8. Have your instructor check your finding.

C. Routine 2—Test the motor start windings

- ☐ 1. Make sure motor is unplugged from its power supply.
- ☐ 2. Remove the GY and R wires from the directional switch.
- ☐ 3. Set the VOM for R x 1 and zero the meter.
- ☐ 4. Connect one test lead to the GY wire and the other test lead to the R wire.
- ☐ 5. Check meter reading and record your finding:
- (a) if the VOM shows an open circuit, check to make sure the GY or R wires are not broken or disconnected at the motor.
 - (b) if wires are okay and meter still indicates an open circuit, the start windings are open and the motor will have to be replaced.
 - (c) if the meter reading is 4 to 10 ohms, the start windings are okay.
- ☐ 6. Have your instructor check your finding.

D. Routine 3—Test the motor centrifugal switch

- ☐ 1. Make sure motor is unplugged from its power source.
- ☐ 2. Disconnect the BU and O or BU and BR wires from the motor switch (wire color will vary with motor).
- ☐ 3. Set the VOM for R x 1 and zero the meter.

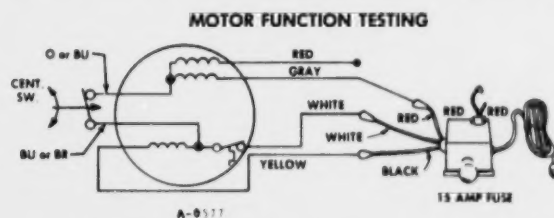
- ☐ 4. Connect one test lead to the BU or O wire and the other lead to the BU or BR wire.
- ☐ 5. Check meter reading and record your finding:
 - (a) if the reading indicates an open, the motor centrifugal switch is stuck or burned and should be replaced.
 - (b) if the meter reading is zero ohms, the switch is okay.
- ☐ 6. Have your instructor check your finding.

E. Routine 4—Test motor functions

- ☐ 1. Make sure unit is unplugged from its power source.
- ☐ 2. Disconnect all motor leads from the centrifugal switch.

Note: The blue and orange or blue and brown leads do not have to be disconnected.

- ☐ 3. Connect the test cord as indicated in the following illustration.



- ☐ 4. Make sure that no leads are touching each other or any part of the cabinet or frame.
- ☐ 5. Plug in test cord, turn the tester switch to the start position for 2 or 3 seconds, and then release the switch.

Note: The switch will return to the run position.
- ☐ 6. Check to make sure that the motor runs in the COUNTERCLOCKWISE direction.
- ☐ 7. Turn the tester off and unplug it from the power supply.
- ☐ 8. Remove the red tester lead from the gray motor lead and connect the red motor lead to the red tester lead.
- ☐ 9. Plug in test cord, turn the tester switch to the start position for 2 or 3 seconds, and then release the switch.

Job Sheet 2

- ☐ 10. Check to make sure the motor runs in the CLOCKWISE direction:
- (a) if the motor now runs clockwise and previously ran counterclockwise, it is okay.
 - (b) if the motor does not run in both directions or in only one direction, it should be replaced.
- ☐ 11. Record your findings.
- ☐ 12. Have your instructor check your work.
- ☐ 13. Clean up area and return tools and materials to proper storage.

Comments _____

**Trash Compactors
Unit 11****Job Sheet 3—Troubleshoot a Trash Compactor for Typical Malfunctions**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

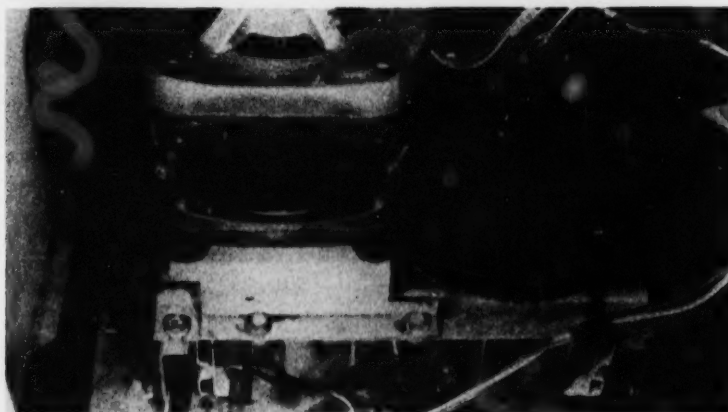
Evaluation Criteria	Rating
Service panels removed for access to wiring schematic	_____
Troubleshooting accomplished for unit that will not run	_____
Troubleshooting completed for ram problems	_____
Preventive maintenance completed	_____

A. Tools and materials

Trash compactor as selected by instructor
Service/installation manual for compactor
Basic hand tools
VOM
Lint-free shop towels
Multipurpose molybdenum grease and SAE 30W oil
Safety glasses

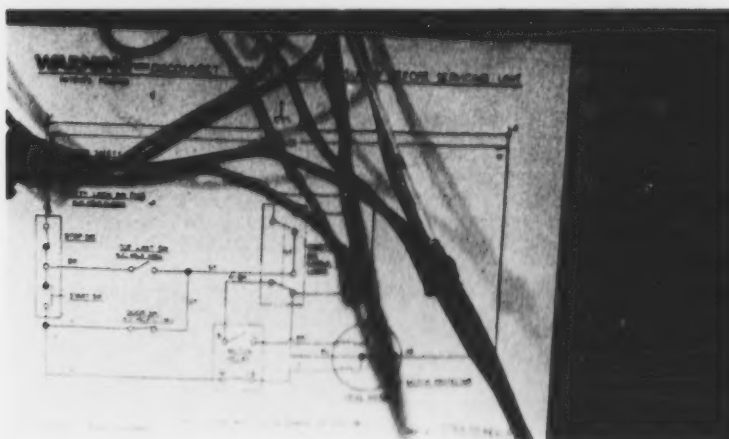
B. Routine 1—Troubleshoot a compactor that will not run

- ☐ 1. Put on safety glasses.
- ☐ 2. Remove the service panel that provides access to the motor.



Job Sheet 3

- ☐ 3. Inspect the motor visually for any signs that it has burned out or the smell of burned components.
 - ☐ 4. Check the motor for shorts or opens:
 - (a) if the motor has an open, the motor must be replaced.
 - (b) if the motor windings are shorted, the motor must be replaced.
 - (c) If the motor is okay, continue with troubleshooting.
 - ☐ 5. Remove service panels as required to reach the ON/OFF switch and the key-actuated safety switch.
 - ☐ 6. Check the ON/OFF switch for continuity and replace as required.
 - ☐ 7. Check the key-actuated safety switch for continuity and replace as required.
 - ☐ 8. Have your instructor check your work.
- C. Routine 2—Troubleshoot a ram that will not return to home position
- ☐ 1. Leave your safety glasses on.
 - ☐ 2. Unplug the compactor and remove the back or front panel as needed to gain access to the wiring schematic.



- ☐ 3. Inspect the power screws for obstructions that might be keeping the ram from returning home.

Job Sheet 3

- ☐ 4. Determine the location of the bottom and top limit switches that control ram travel.



- ☐ 5. Remove one of the leads to the upper limit switch and make a continuity check on the upper limit switch.
- ☐ 6. Set the VOM on R x 1, zero the meter, and then place the two VOM leads onto the terminals of the upper limit switch.
- ☐ 7. Press the actuator switch on the upper limit switch and look for a full scale deflection:
- (a) if there is no full scale deflection, the upper limit switch is bad and should be replaced.
 - (b) if there is a full scale deflection, the upper limit switch is okay, but may require adjustment.

Job Sheet 3

- (c) if adjustment is required, it usually involves no more than loosening the screw that secures the switch, moving the switch up or down as required, and then retightening the screw, but be sure to check the service manual for the compactor with which you are working.



- ☐ 8. Repeat the continuity check for the lower limit switch and adjust or replace as required.
 - ☐ 9. Plug the compactor in and test for proper ram movement into the home position.
 - ☐ 10. Have your instructor check your work.
- D. Routine 3—Complete preventive maintenance on a trash compactor
- ☐ 1. Leave your safety glasses on.
 - ☐ 2. Lubricate the power screws with a multipurpose high-pressure grease.
 - ☐ 3. Lubricate the side rollers with SAE 30W oil.
 - ☐ 4. Check tension on the drive belt and adjust to specifications in the service manual.
 - ☐ 5. Test run the compactor to make sure all operations are proper.
 - ☐ 6. Have your instructor check your work.
 - ☐ 7. Replace all panels that were removed.
 - ☐ 8. Clean up area and return tools and materials to proper storage.

Comments _____

Gas Ranges and Ovens

Unit 12

Objective Sheet



Unit Objective

After completing this unit, the student should be able to use wiring schematics to determine voltage and resistance readings on a self-cleaning gas oven at selected points in an operational cycle. The student should also be able to install a gas range level and leak free with all burners properly adjusted, use a temperature tester to check gas oven temperature for proper oven thermostat settings, recalibrate a gas oven thermostat to correct settings, and remove, disassemble, clean, lubricate, and reassemble a standard gas burner valve. The student should demonstrate these competencies by completing the activities in the assignment and job sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to gas ranges and ovens with their correct definitions.
2. Complete statements about the basics of gas heating.
3. Select true statements about natural and bottled gas.
4. Complete statements about how a gas range top burner works.
5. Select true statements about orifice settings.
6. Select true statements about primary and secondary air.
7. Complete statements about byproducts of combustion.
8. Recommend solutions for burner combustion problems.
9. Complete a chart of gas burner types and applications.
10. Match types of oven ignition systems with their characteristics.
11. Complete statements about how a gas oven works.
12. Match types of oven thermostats with their characteristics.
13. Complete statements about safety valves.
14. Complete statements about common misuses of gas ovens.

Objective Sheet

15. Select true statements about special considerations for ovens with upper and lower burners.
16. Complete statements about how self-cleaning ovens work.
17. Select true statements about special safety features of self-cleaning ovens.
18. Complete a list of safety requirements for gases.
19. Complete statements about flexible connectors.
20. Select true statements about requirements for gas supply lines.
21. Complete statements about functions of electrical circuits on gas ovens.
22. Solve problems about typical circuit functions in a gas oven.
23. Match gas range complaints with recommended troubleshooting.
24. Select true statements about gas pressure drops.
25. Solve problems about manometer selection and use.
26. Complete statements about guidelines for roasting.
27. Complete statements about guidelines for broiling.
28. Complete statements about guidelines for baking.
29. Match baking problems with their solutions.
30. Select true statements about guidelines for customer service calls.
31. Determine voltage and resistance readings on a self-cleaning gas oven set for a bake operation. (Assignment Sheet 1)
32. Determine voltage and resistance readings on a self-cleaning gas oven set for a timed bake operation. (Assignment Sheet 2)
33. Determine voltage and resistance readings on a self-cleaning gas oven set for a cleaning operation. (Assignment Sheet 3)
34. Determine voltage and resistance readings on a self-cleaning gas oven during lock and unlock. (Assignment Sheet 4)
35. Install a gas range level and leak free with all burners properly adjusted. (Job Sheet 1)
36. Check gas oven temperature for proper oven thermostat settings. (Job Sheet 2)

Objective Sheet

37. Recalibrate a gas oven thermostat to correct settings. (Job Sheet 3)
38. Remove, disassemble, clean, lubricate, and reassemble a standard gas burner valve. (Job Sheet 4)

Gas Ranges and Ovens Unit 12

Information Sheet

1. Terms and definitions

- a. **AGA (American Gas Association)**—A national organization that sets design and performance standards for gas appliances, and conducts laboratory and on-site checks for compliance
- b. **Baffle**—A metal sheet (flat or slightly V-shaped) placed over an oven burner to divert heat to both sides of a gas oven and to keep direct flame off the oven bottom to prevent burnout
- c. **Burner valves**—Valves that screw into a gas manifold to control gas flow to the top burners
- d. **Charge port**—A small fitting mounted on the side of a burner where it directs gas through a flash tube to a pilot light to cause the burner to ignite
- e. **Gas regulator**—Controls gas pressure and gas flow into the manifold and to other gas range components
- f. **LP (liquid propane) gas**—A general reference to both propane and butane gases used for heating and cooking purposes when natural gas is unavailable
- g. **Manifold**—A pipe which receives gas from the gas supply and distributes that gas to the burner valves and the oven thermostat on a gas range
- h. **Manometer**—An instrument, usually a U-shaped glass tube, for measuring the pressure of gases or vapors
- i. **Thermostat**—A device mounted onto a manifold to control gas flow to an oven much like burner valves control gas flow to top burners on a gas range
- j. **Venturi**—a tube-like connection where air and gas are mixed and transported to a top burner on a gas range

2. Basics of gas heating

- a. Gas heating and cooking devices are rated according to a unit of heat known as BTU (British Thermal Unit).
- b. A BTU is equal to the amount of heat required to raise one pound of water one degree Fahrenheit.

Note: A common wood match will release about 1 BTU as it completely burns up.

Information Sheet

- c. Gases are rated in BTU's (Transparency 1)
 - (1) Natural gas may range from 300 to 3,000 BTU per cubic foot.
 - (2) The standard for natural gas in America is almost always 1,000 BTU per cubic foot, and most heating and cooking appliances are designed with that standard in mind.
 - (3) A gas range should list the BTU rating of every burner and the oven on the name plate. (Transparency 2)
- d. Gas burners are designed according to their intended use.
 - (1) A standard size surface burner for household use is usually rated about 9,000 BTU/hr.
 - (2) A jumbo size burner for commercial use is usually rated about 12,000 BTU/hr.
 - (3) Oven burners for household use are usually rated about 23,000 BTU/hr.
- e. Burner ratings should never be surpassed.

3. Natural and bottled gases

- a. Natural gas comes from wells and is usually piped from a central supply point to homes and businesses in an area.
- b. Propane and butane are extracts from crude petroleum and are stored in bottles and tanks as a liquid, and then changed to gas when they are used.
- c. Because of its convenience, natural gas is the most common gas used for gas appliances, but in areas remote from a central natural gas supply, propane and butane are used.
- d. Natural gas is heavier than air and will collect in low spots, but propane and butane are lighter than air and will rise in the atmosphere.

Note: These characteristics can cause problems with wrongly positioned pilot lights.
- e. Natural gas, propane, and butane are all odorless and colorless and have mercaptan added to them to provide color and a pungent odor so leaking gas can be quickly detected.

Note: Mercaptan has a high sulphur content and smells like rotten eggs.

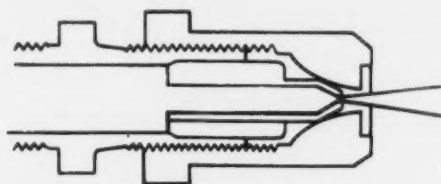
Information Sheet

4. How a gas range top burner works (Transparency 3)

- a. The main gas supply goes through a gas regulator valve which assures gas will be delivered to the range at a constant proper pressure.
- b. The gas regulator valve feeds gas into a manifold which serves as a gas transmission line to the top burners, oven pilot, and oven burner.
- c. For a top burner, a gas control valve is screwed into the manifold so that it can be manually operated to turn gas on or off.
- d. From the gas control valve, gas goes through a spud which is screwed into the valve, and from the spud through an orifice with a hood that holds it in place.
- e. Gas from the orifice is fed into a venturi where an air shutter allows air in to mix with the gas.
- f. As gas is mixing in the venturi and being carried to the burner, another constant gas flow is going down a separate tube to the pilot.
- g. As gas from the venturi reaches the burner, part of it passes out a flash port on the side of the burner, and is directed down a flash tube to the pilot flame.
- h. As the pilot flame ignites gas from the flash port, gas at the burner itself is ignited, combustion is complete, and burning begins.

5. Orifice settings

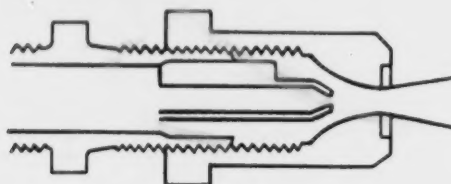
- a. Depending on geographical location, a range will come from the manufacturer with the orifice preset for either natural gas or LP gas.
- b. An orifice for LP gas cannot be used with natural gas because the opening is too small, and an orifice for natural gas cannot be used with LP gas because the opening is too large and would create a fire hazard.
- c. If the orifice in the range is improper for the local gas supply it must be replaced with the proper orifice.
- d. If the orifice is a universal orifice, it can be adjusted for LP gas by tightening the hood until it is against the needle.



L.P. Setting

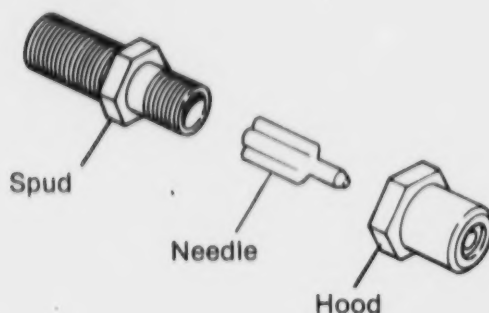
Information Sheet

- e. The universal orifice can be adjusted for natural gas by screwing the orifice hood out to achieve proper flame size.



Natural Setting

- f. If the needle is solid, no hole in the center, the orifice opening can only be adjusted by changing to another hood with an opening sized either for LP gas or natural gas.
- g. When connecting the hood to a venturi, it may be necessary to use an extension called a spud to reach into the venturi the proper distance.



6. Primary and secondary air

- a. Primary air enters the gas supply through an air shutter located at the front of the venturi.
- b. Primary air is mixed with gas in the throat of the venturi and enters the burner combustion area as an air/gas mixture which is ignited.
- c. Secondary air comes from the entire area around the burner and mixes with the flame as it comes from the burner.
- d. Secondary air stabilizes the flame, completes combustion, and carries off the byproducts of combustion.

Information Sheet

7. Byproducts of combustion

- a. When gas burns it gives off water vapor which is usually absorbed by the atmosphere around the range area.
- b. When a home or kitchen area is improperly ventilated, water vapor may condense on walls or other surfaces.

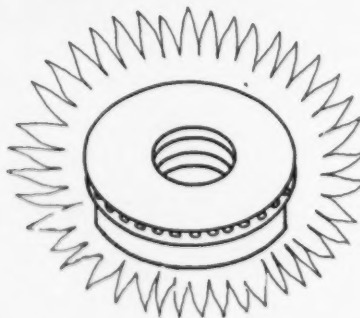
Note: This is more of a problem in winter weather when outside walls are cold.

- c. Improper combustion that leaves part of the gas unburned will produce CO (carbon monoxide) which is extremely dangerous to humans.
- d. Although CO is odorless and colorless, it can usually be quickly detected because it is accompanied by other gases called aldehydes which do have a pungent odor and irritate the nose and eyes.
- e. When there is an indication that CO is present, the appliance should be shut down and not used until it has been properly adjusted.

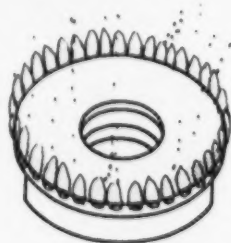
Note: Properly adjusted gas appliances pose no CO danger.

8. Burner combustion problems and their solutions

- a. If a flame is literally leaping off a burner, there is too much primary air and the air shutter should be closed down as required.

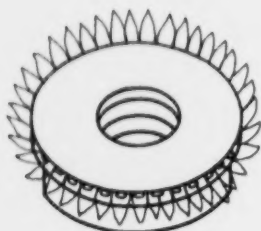


- b. If a flame burns yellow and produces soot, there is not enough primary air and the air shutter should be opened up as required.

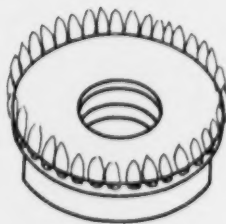


Information Sheet

- c. If the flame looks lazy and seems to float away from the burner, the secondary air supply is insufficient, and this may require cleaning out a blocked flue or dirty air vents.



- d. In addition to flue or vent blockage, secondary air problems may be caused by:
- (1) overrating the burner and sending more gas than a limited air supply can handle.
 - (2) bad location of the range so that there is insufficient draft for secondary air, and not enough air to carry off the byproducts of combustion.
- e. When there is a problem with primary air, always start the adjustment with the shutter completely open and close it slowly until the flame is correct.
- f. When properly adjusted with the gas valve wide open, natural gas should give a bluish flame with a well defined center cone with a flame about $\frac{3}{4}$ " high.



- g. A proper LP gas flame should be colored like a natural gas flame, but should be about $\frac{1}{2}$ " high with the gas valve wide open.

9. Gas burner types and applications (Transparency 4)

Type of Burner	Shape	Application	Performance
Drilled-Ring	Circular	Top surface burners	Is most efficient burner because it provides a better supply of secondary air to all parts of the flame
Drilled-Pipe	Star	Top surface burners	Permits more drilled holes to provide better heat distribution and greater capacity for large pots and pans used commercially
Drilled-Pipe	Oval, straight line, or special configuration	Ovens, trays, tanks, and special application	Permits even distribution of heat over surfaces of large oven, tray, or tank areas in cases where circular or star burners could heat only a part of the surface

10. Types of oven ignition systems and their characteristics**a. Automatic ignition (Transparency 5):**

- (1) most popular type,
- (2) has no standing pilot,
- (3) goes through ignition process each time the oven calls for heat, and
- (4) may use sparking points, glow coil, or a silicon carbide coil for ignitions.

b. Semi-automatic ignition (Transparency 6):

- (1) gas supply controlled by a thermostat in the manifold,
- (2) uses same gas regulator and manifold as top burners,
- (3) as gas reaches the oven burner, it is ignited by a standing pilot,

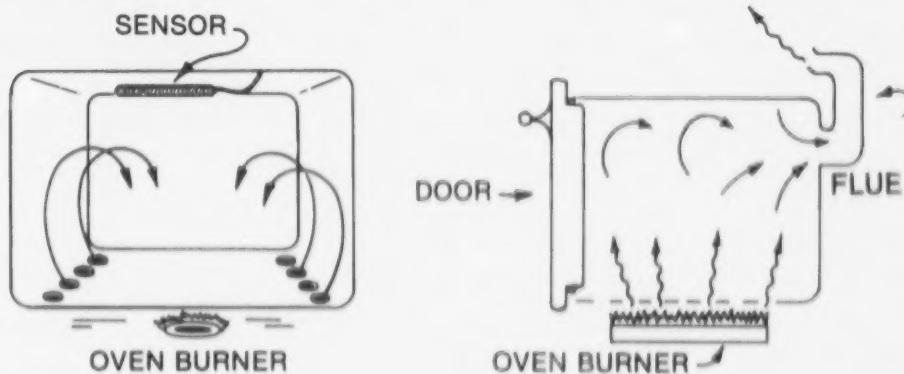
Information Sheet

- (4) a thermostat senses ambient temperature in the oven and shuts off gas supply when oven heats to a specified temperature, and
 - (5) thermostat also turns gas supply back on when oven cools below specified temperature.
- c. Manual ignition (Transparency 7):
- (1) gas enters oven burner when thermostat is turned on,
 - (2) burner must be lit with a match placed at the entrance to a flash tube,
 - (3) precautionary pilot comes on only after oven burner has ignited,
 - (4) thermostat bypasses enough gas to maintain a minimum flame,
 - (5) precautionary pilot goes out when the thermostat is turned off,
 - (6) oven must be manually lit each time it is used, and
 - (7) these type ovens are no longer manufactured, but some are still around.

11. How a gas oven works

- a. After the oven burner is ignited, heat from the burner enters the oven cavity through a row of holes along each side of the oven bottom.
- b. Hot air circulates through the oven and around food placed into the oven.
- c. There are byproducts of combustion that are carried along with the hot circulating air out of the oven and into the oven flue.
- d. Hot air also circulates around the thermostat capillary tube so oven temperature can be controlled.

- e. Oven may be shut off manually or shut off by a timer control or a temperature-probe control.



12. Types of oven thermostats and their characteristics

a. Hydraulic thermostat (Transparency 8):

- (1) usually filled with oil,
- (2) as oil is heated or cooled it activates or deactivates a bellows, and
- (3) the bellows move or close a disc valve to start or stop gas flow.

b. Electric hydraulic thermostat (Transparency 9):

- (1) used only in electrically controlled gas ranges or in electric ranges,
- (2) uses a liquid filled sensing bulb to activate or deactivate a bellows, and
- (3) instead of moving a disc valve, the bellows opens or closes a set of contact switches to start or stop gas flow.

c. Pneumatic thermostat (Transparency 10):

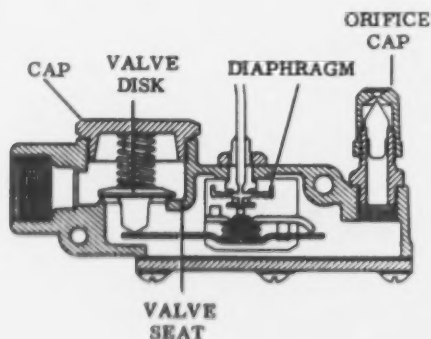
- (1) used in self-cleaning gas ovens because a thermostat with liquid in the design would not operate at the 850° to 900° temperatures needed to clean an oven,
- (2) works with a C-shaped bourdon tube, a thermostat tube, and a sensing bulb all filled with helium,
- (3) heat creates vapor pressure which causes the bourdon tube to straighten out,
- (4) cooling causes the bourdon tube to return to its original position,

Information Sheet

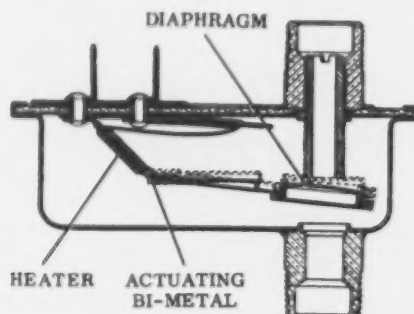
- (5) the action of the bourdon tube controls the temperature control contacts to keep the burner cycling on and off as needed, and
- (6) the action of the bourdon tube also controls the door lock contacts so the oven door is locked shut during the self-clean cycle.

13. Safety valves

- a. Safety valves on gas ranges serve two valuable safety purposes:
 - (1) gas from the main gas supply will not flow if the pilot light is out when the gas is turned on.
 - (2) gas from the main gas supply will be shut off if the pilot goes out while the oven is in operation.
- b. One common safety valve works with a mercury sensing bulb that has to be heated by the oven pilot before it will open, and will close immediately if the pilot goes out.

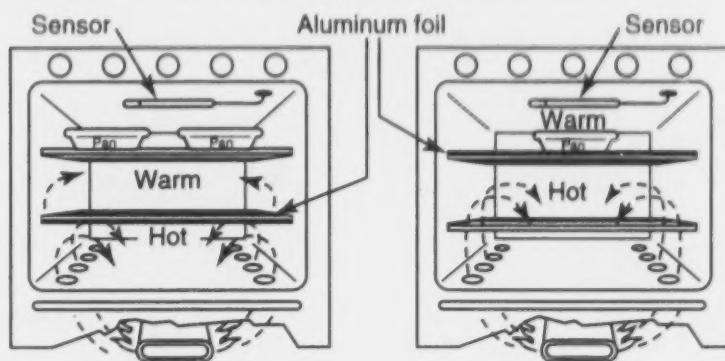


- c. Another type safety valve uses a bi-metal actuating device with a wrap-around heater, and this valve works in conjunction with a flame switch which sense whether the pilot is lit or not lit.

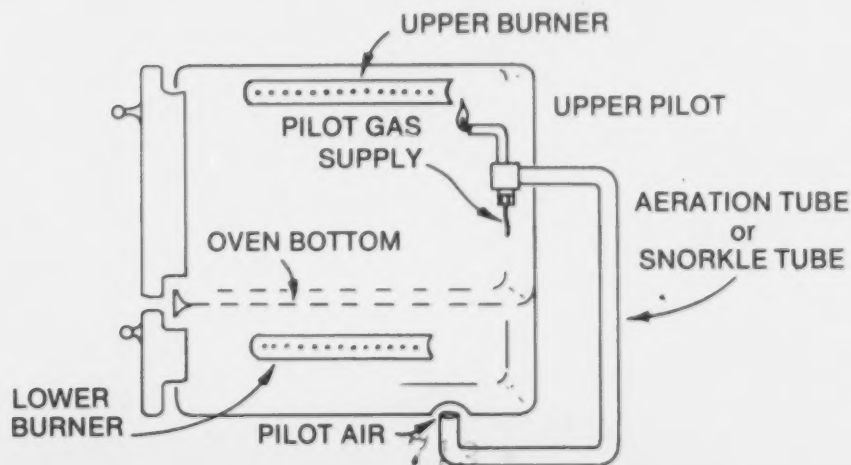


14. Common misuses of gas ovens

- a. Covering the holes at the bottom of the oven will cause baking problems and damage the oven.
- b. Using large pieces of foil to catch spills will literally divide the oven into improperly heated parts and cause baking problems.
- c. Placing utensils too close to the oven wall will also impair circulation and jamming too many pans on one shelf will impair circulation.

**15. Special considerations for ovens with upper and lower burners**

- a. In a two-burner oven, the upper burner pilot requires a separate fresh air supply because the upper pilot cannot burn in the byproducts of combustion from the lower burner.
- b. To assure the upper burner pilot will have a proper fresh air supply requires a separate tube to bring fresh air to the upper pilot.
- c. Fresh air supply to an upper burner is usually accomplished with a snorkle-like tube that brings fresh air from outside the oven and serves no other function.



Information Sheet

16. How self-cleaning ovens work

- a. Most oven spills are forms of hydrocarbons that break down into water and gases when burned in a temperature above 850°F.
- b. The intense heat causes a decomposition process called pyrolysis and leaves a white ash that can be easily wiped off.
- c. In most gas ovens, smoke and other byproducts of self-cleaning are directed out of the oven flue.

17. Special safety features of self-cleaning ovens

- a. Since the high temperatures in the self-cleaning function pose a fire danger and danger to the operator, special safety features are built into self-cleaning ovens.
- b. A metal-mesh protection screen must be manually pulled into place over the glass in the oven door before the oven door can be manually latched for self-cleaning.

Note: Because the cleaning process is accomplished through use of a special coating on the oven liner, a continuous-cleaning oven does not require the high temperature of a self-cleaning oven and the metal-mesh screen and other safety devices are not required on a continuous-cleaning oven.

- c. As another safety feature, an inside thermometer activates an inside door lock when the oven reaches 550°F.
- d. The inside door latch stays in place until the oven cools back down to less than 550°F.

Caution: Attempting to open an oven door while the self-cleaning function is in progress could cause serious burns and introduce enough oxygen into the oven to cause an explosion, and operators are encouraged to stay away from ovens during self-cleaning and never attempt to look in through the glass of the oven door.

18. Safety requirements for gases

- a. Be sure to shut off all gas appliances before turning off the main gas supply.
- b. Smoking while working around gas appliances is **ABSOLUTELY FORBIDDEN**.
- c. Never use a match or any open flame to test for gas leaks.

Information Sheet

- d. Test for leaks by brushing on a soap-water mixture and watching for bubbles which would indicate a leak.

Note: Liquid detergent mixed with water until it has a syrupy quality is good for leak testing, and there are commercial leak testing fluids such as LeakTec which are available at supply houses.

- e. Use pipe dope, Teflon tape, or Teflon dope when making up connections on supply lines that are made of steel.
- f. Do not use pipe dope on any brass fitting except when mating a brass fitting to a steel supply line.
- g. Propane and butane will dissolve some pipe dope, so be sure you use dope that is LP gas resistant.
- h. Do not expose your bare hands or skin to propane or butane because they absorb heat so fast that escaping gas can cause frostbite.
- i. Keep propane and butane tanks away from excessive heat.
- j. Never fill a propane or butane tank completely full because both gases require expansion space.
- k. Never use rubber gaskets or washers around propane or butane because both gases will dissolve rubber.

19. Flexible connectors

- a. Flexible connectors make hooking up a range much easier, but be sure local codes permit the use of flexible connectors before installing one.

Note: Some local codes still require rigid pipe hookups, and this is almost always true for gas appliances in mobile homes.

- b. Bend or shape flexible connectors with care because they are made of copper and are fairly easy to break.
- c. Plastic-coated (epoxy) flexible connectors are preferred because bare copper connectors readily corrode in situations where propellants from canned aerosol cooking aids can reach them.

Note: Spray butter substitutes such as Pam contain such propellants.

Information Sheet

- d. Use no pipe dope on brass fittings except the connector fitting from a steel pipe inlet.
- e. Use only connectors that have dielectric qualities and the AGA seal of approval that indicates the connector meets AGA requirements.
- f. Limit flexible connections to no more than six feet.
- g. Make sure the connector is properly sized to match the gas branch line to which it is connected.

20. Requirements for gas supply lines

- a. Most incoming gas supply lines have a diameter of 1".
- b. Most feeder lines off the main gas supply lines have a diameter of 1/2".

Note: A branch line to a gas clothes dryer may have a 3/8" line because the BTU requirements for a gas dryer are less than for a range or water heater, but piping sizing should be increased in situations where several gas appliances may be in use at one time.

- c. Piping used for gas transport must be made of black iron or galvanized iron.
- d. Pipe dope, Teflon dope, or Teflon tape should be used when making up all joints and connections on black iron or galvanized iron.

21. Functions of electrical circuits on gas ovens

- a. Electrical circuits on self-cleaning gas ovens operate oven lights, clocks, and timing devices.
- b. Electrical circuits on gas ovens also operate the door lock switch and other elements of the self-cleaning function.

22. Typical circuit functions in a gas oven

- a. When circuits are energized for a simple BAKE function, oven burner operation is controlled through the selector switch and thermostat. (Transparency 11)
- b. When circuits are energized for a TIMED BAKE function, the length of the oven burner operation is controlled through a clock. (Transparency 12)

Information Sheet

- c. When circuits are energized for the CLEAN operation in a self-cleaning oven, the cleaning temperatures are controlled by the opening and closing of the thermostatic contacts of the oven control. (Transparency 13)

Note: During opening and closing of the thermostatic contacts, the heating element in the smoke eliminator is energized, and the smoke eliminator fan blows the byproducts of combustion into the flue.

- d. When circuits are energized for the LOCK operation in a self-cleaning oven, terminals in the oven control open to cause the lock indicator light to come on, and the unlocking mechanism cannot be energized. (Transparencies 13 and 14)
- e. When circuits are energized for the UNLOCK operation, oven control contacts close as the oven cools down to 550°F and cause a selector switch to activate the unlock solenoid which withdraws the safety rod so the door can be unlocked. (Transparency 14)

23. Gas range complaints and recommended troubleshooting

- a. When the complaint is that the pilot light is out and will not light or will not stay lit, check for:

- (1) a poorly adjusted pilot light,
- (2) poorly adjusted burner flame so high that it puts the pilot out, or
- (3) bad safety valve or thermocouple.

- b. When the complaint is that the top burner will not light or that the flame is too high or too low, check for:

- (1) top burner pilot light out,
- (2) flash tube to pilot clogged or out of position,
- (3) burner itself out of position,
- (4) flash port clogged,
- (5) burner itself clogged,

Note: This problem could produce smoke residue on utensils, and is a sure sign that the user needs to be encouraged to clean food spills from the burner as soon as possible after they happen.

- (6) improper primary air, or
- (7) wrong size orifice.

Information Sheet

- c. When the complaint is that the flame jumps off the burner or that the flame is smoky, check for:
 - (1) too much primary air through the shutter, or
 - (2) too little primary air through the shutter.
- d. When the complaint is that the oven is not heating properly, check for:
 - (1) oven thermostat problems,
 - (2) bypass gas supply problems,
 - (3) improper calibration of oven thermostat,
 - (4) improper burner adjustment, or
 - (5) improper gas pressure.
- e. When the complaint is that the oven is sweating, check for:
 - (1) improper preheating (oven door may need to be left open),
 - (2) oven thermostat temperatures incorrect (recalibration), or
 - (3) clogged oven vent.
- f. When there is a complaint that there is an odor of gas around the range, check for:
 - (1) gas leak in connections along supply lines,
 - (2) oven burners not getting enough primary air, or
 - (3) oven pilot touching burner.

24. Gas pressure drops

- a. No gas appliance will operate properly at a gas pressure less than the appliance is rated for.
- b. Gas ranges have gas pressure ratings expressed in ounces of gas pressure per square inch (PSI).
- c. An average gas rating for natural gas is 4 oz. PSI, and for LP gas, 10 oz. PSI.
- d. With natural gas, a pressure drop can be regulated at the appliance, but with an LP gas pressure drop, the adjustment has to be made at the LP supply tank.
- e. The two most common causes of pressure drops are:
 - (1) an obstruction in the main gas supply line, usually water, or
 - (2) undersized piping that will not serve multi-appliance demands.

Information Sheet

- f. Water problems are frequent with gas lines in high-acidity soils because acid attacks and corrodes the iron pipe.

Note: Water can easily penetrate pinholes in the pipe because the water pressure will be much greater than the normal 4 oz. PSI inside the pipe.

- g. Pilot lights that keep going out, and erratic burner operation are signs of water problems.
- h. In situations where several gas appliances are in use at one time, undersized piping will cause pressure drop.
- i. The handiest tool for troubleshooting a complaint of gas pressure drop is a water or a mercury manometer, and since the water manometer is easier to work with and easier to read, it is a useful tool.

Note: The mercury manometer must be read in pounds per square inch and then converted to ounces per square inch, but the reading with a water manometer is direct and no conversion is required, and because of this, many technicians feel the water manometer is the more accurate of the two.

25. Manometer selection and use (Transparency 15)

- a. A water manometer is probably easier to work with than a mercury manometer and the conversion from inches of water column to ounces of pressure is easier to take.
- b. When a gas pressure drop is suspected, it is always best to have the local gas utility check for proper gas pressure at the meter.



Information Sheet

c. The next check should be at the range itself:

- (1) fill the manometer with enough water that the water level is zero on each side of the scale,
- (2) remove the venturi from a surface burner and place the manometer tube over the orifice spud,

Note: Some manifolds have a special plug that can be removed and the manometer tube can be fitted to the manifold with a special connector, but simply putting the tube over the orifice will provide an accurate measurement.



- (3) turn the gas valve full ON and read the inches of water column on the right side of the manometer glass,
- (4) write down your manometer reading in inches and tenths of an inch,
- (5) convert inches of water column to ounces per square inch according to the table in Transparency 15,
- (6) check the nameplate for the pressure specified for the range, and

Example: A common pressure rating for a natural gas range is 4 oz. PSI or 7 inches water column, and a common rating for an LP range is 10 oz. PSI or 18 inches of water column

Information Sheet

- (7) compare your finding with the nameplate information and adjust the gas valve as required.
- d. When gas valve adjustment will not correct the problem, make the following check:
 - (1) leave the manometer hooked up to the range with the test burner turned to full ON,
 - (2) if the home has a gas furnace, start the furnace and look for a pressure drop on the manometer, and
 - (3) if there is a noticeable pressure drop, it is an indication that the gas supply line is undersized and the customer should be advised to have the piping changed by a licensed plumber.

26. Guidelines for roasting**a. Factors that increase roasting time:**

- (1) roasts that are boned and tied take more time to cook than standing roasts,

Note: The ties on the roast actually increase the density of the meat and increased density requires more cooking time.

- (2) small roasts require more cooking time per pound than do large roasts, and
- (3) wrapping meat or poultry in foil increases roasting time.

b. Factors that decrease roasting time

- (1) a thick coating of fat decreases roasting time,
- (2) selecting aged meat decreases roasting time, and
- (3) selecting standing roasts (not boned and tied) decreases roasting time.

c. Using a thermometer for roasting

- (1) a thermometer should be inserted into the center of the thickest part of the meat,
- (2) the tip of the thermometer probe should not be allowed to contact areas of gristle, fat, or bone,

Note: Bone and fat register higher temperatures than the meat adjacent to them and can give deceptive readings.

Information Sheet

- (3) generally, a probe should be inserted 3 ½" into the meat, and if it is a thin roast, the probe should be inserted from an angle that will give it a 3 ½" penetration, and
- (4) for poultry, a thermometer should be inserted into the center of the breast above the wing or into the inside of the thigh muscle.

27. Guidelines for broiling

- a. Broiling is popular because it reduces fat content and enhances taste.
- b. Broiling is also popular because it is about the only way to please people who like their steaks browned on the outside and rare in the middle.
- c. Selecting steaks for broiling:
 - (1) for outside browning and a rare inside, the steak must be at least 1" thick, and it is better if it is slightly thicker,
 - (2) the steak should be kept at refrigerator temperature until broiling begins,
 - (3) the best way to assure the brown/rare combination is to broil a frozen steak directly from the freezer,
 - (4) place the steak as close to the broiler unit as possible, and
 - (5) preheating the oven also helps to control the brown/rare combination.
- d. Ways to promote browning:
 - (1) as fat content in a steak increases, browning increases,
 - (2) brushing any meat with butter or oil will increase browning,
 - (3) seasoning meats after broiling will increase browning because salt added prior to broiling produces moisture which delays browning, and
 - (4) handle aged steak with care because the outside cooks rapidly and the inside may be too rare.

Note: Moving the steak farther away from the broiling element will sometimes solve the problem with aged beef.

28. Guidelines for baking**a. Placement of shelves and pans;**

- (1) use the middle shelf when baking on only one shelf, and space shelves so that they divide the oven in thirds when using more than one shelf.
- (2) do not impair heat circulation by placing a pan too close to the oven wall and with two or three pans, stagger them so that there is a good heat circulation around each one.

b. Preheating:

- (1) cakes, pies, and other delicate foods require preheating, so follow the recipe.
- (2) preheating is not usually required for meat and poultry.

c. Using foil:

- (1) if oven shelves are completely covered with foil, heat circulation in the oven will be improper.
- (2) foil placed directly under a pie may interfere with bottom browning.

d. Selecting pans and bakeware:

- (1) shiny aluminum is best for cakes, but glass can be used if oven temperature is lowered 25 degrees.
- (2) glass pie plates are best for pies, but dark tin or anodized aluminum can also give satisfactory results.
- (3) shiny baking sheets are best for biscuits and cookies.
- (4) anodized aluminum or glass are best for yeast breads because they help make the crust thick.
- (5) a dull cookie sheet is best for frozen pies because it helps browning of the bottom crust.

29. Baking problems and their solutions

Note: Some of the following items apply onto gas ovens, but most items apply to both electric and gas ovens.

- a. When baked goods burn on the top:
 - (1) oven flame may be too hard and primary air should be decreased.
 - (2) baffle may be out of position or upside down, so position baffle properly.
 - (3) flue may be blocked and it should be cleaned.
- b. When baked goods burn on one side:
 - (1) cookware is blocking heat circulation, so position cookware away from sides of oven.
 - (2) pan may be unlevel or the range may be unlevel, so level the range or replace the utensil as required.
- c. When baked goods burn on the bottom:
 - (1) oven flame may be too soft and primary air should be increased.
 - (2) baffle may be out of position or upside down, so position baffle properly.
 - (3) dark cookware should be exchanged for a brighter utensil.
 - (4) flue may be blocked and it should be cleaned.
- e. When baked goods are soggy:
 - (1) oven is too hot and thermostat should be checked, or a higher temperature should be used.
 - (2) batter may have wrong ingredients, so check the recipe.
 - (3) baked item may have been left in the pan too long, and it should be removed immediately.

30. Guidelines for customer service calls

- a. Introduce yourself to the customer, identify your company, and confirm that you are there in answer to the customer's request for service.
- b. Ask the customer to explain the problem in his/her own words.
- c. Check to see if baking problems provide a clue to the trouble before looking for mechanical problems.
- d. Place a drop cloth around the range area before starting any work.
- e. Request the customer to keep the area free of children and pets.

Gas Ranges and Ovens
Unit 12

**Assignment Sheet 1—Determine Voltage and Resistance Readings
on a Self-Cleaning Gas Oven Set for a Bake Operation**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Number of answers attempted	_____
Numbers of answers correct	_____

Directions: Refer to the schematic that accompanies this assignment. Assume that you are working with a VOM. Circle the correct answer to each of the following problems.

- A. If your VOM is set to read voltage and the meter leads are on Terminal 1 of the oven control and Terminal 5 of the selector switch, what voltage would the meter indicate?

Answer: 0 volts 120 volts 240 volts

- B. With the VOM still set to read voltage and the meter leads on Terminal 1 of the oven control and L, of the selector switch, what voltage would the meter indicate?

Answer: 0 volts 120 volts 240 volts

- C. With the VOM still set to read voltage and the meter leads on Terminal 1 of the oven control and Terminal C of the selector switch, what voltage would the meter indicate?

Answer: 0 volts 120 volts 240 volts

- D. With the VOM still set to read voltage and the meter leads still on Terminal 1 of the oven control and L, of the selector switch, what voltage would the meter indicate if you were to open the oven door?

Answer: 0 volts 120 volts 240 volts

- E. With the electric supply unplugged, the VOM set to read resistance, and the meter leads on Terminal 6 of the selector switch and the white wire to the right of the smoke eliminator, what will the resistance reading be?

Answer: 10 Ω 100 Ω 10,000 Ω

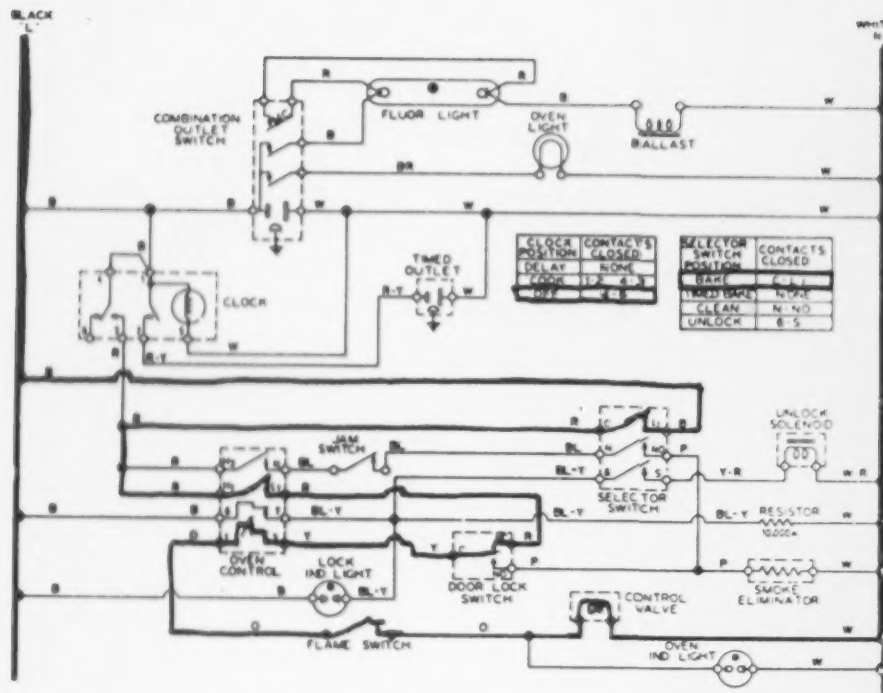
Assignment Sheet 1

- F. With the electric supply unplugged, the VOM set to read resistance, and the meter leads on Terminal 6 of the selector switch and the BL-Y on the lock indicator light, what will the resistance reading be?

Answer: 10 Ω 100 Ω 0 Ω (infinity)

Assignment Sheet 1

MAR-449



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Gas Ranges and Ovens
Unit 12

MAR-451

Assignment Sheet 2—Determine Voltage and Resistance Readings
on a Self-Cleaning Gas Oven Set for a Timed Bake Operation

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Number of answers attempted	_____
Numbers of answers correct	_____

Directions: Refer to the schematic that accompanies this assignment. Assume that you are working with a VOM. Circle the correct answer to each of the following problems.

- A. If your VOM to the schematic that accompanies this assignment. Assume that you are working with a VOM. Circle the correct answer to each of the following problems.

Answer: 0 volts 120 volts 240 volts

- B. With the VOM still set to read voltage and the meter leads on Terminal 2 of the clock and on the white wire to the right of the control valve, what voltage would the meter indicate?

Answer: 0 volts 120 volts 240 volts

- C. With the VOM still set to read voltage and the meter leads on Terminal H, on the oven control and pin S of the selector switch, what voltage would the meter indicate?

Answer: 0 volts 120 volts 240 volts

- D. With the electric supply unplugged, the VOM set to read resistance, and the meter leads on Terminal 1 on the clock and Terminal 1 on the oven control, what will the resistance reading be?

Answer: 10 Ω 100 Ω 10,000 Ω

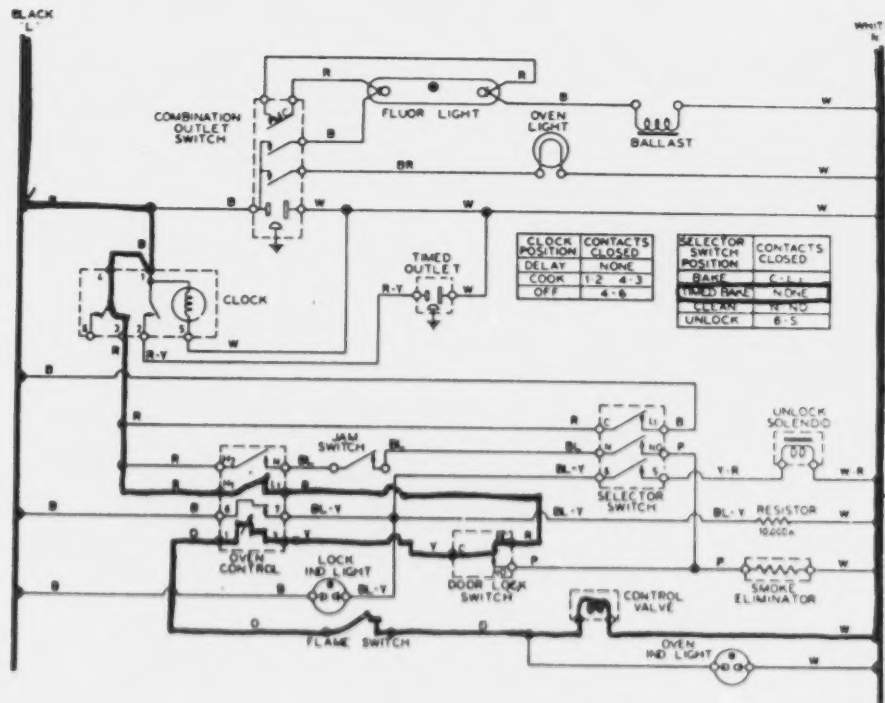
Assignment Sheet 2

- E. With the electric supply unplugged, the VOM set to read resistance, and the meter leads on Terminal 3 of the oven control and the white wire just to the right of the control valve, what will the resistance reading be?

Answer: 10 Ω 100 Ω 10,000 Ω

Assignment Sheet 2

MAR-453



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731

Gas Ranges and Ovens
Unit 12

MAR-455

**Assignment Sheet 3—Determine Voltage and Resistance Readings
on a Self-Cleaning Gas Oven Set for a Cleaning Operation**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Number of answers attempted	_____
Numbers of answers correct	_____

Directions: Refer to the schematic that accompanies this assignment. Assume that you are working with a VOM. Circle the correct answer to each of the following problems.

- A. If your VOM is set to read voltage and the meter leads are on Terminal 6 of the oven control and the white wire just to the right of the unlocking solenoid, what voltage would the meter indicate?

Answer: 0 volts 120 volts 240 volts

- B. With the VOM still set to read voltage and the meter leads on Terminal 1 of the clock and Terminal L, on the selector switch, what voltage would the meter indicate?

Answer: 0 volts 120 volts 240 volts

- C. With the VOM still set to read voltage and the meter leads on Terminal 1, on the oven control and white wire just to the right of the smoke eliminator, what voltage would the meter indicate?

Answer: 0 volts 120 volts 240 volts

- D. With the electric supply unplugged, the VOM set to read resistance, and the meter leads on the left hand terminal of the timed outlet and Terminal C on the selector switch, what will the resistance reading be?

Answer: About 100 Ω About 600 Ω About 1,000 Ω

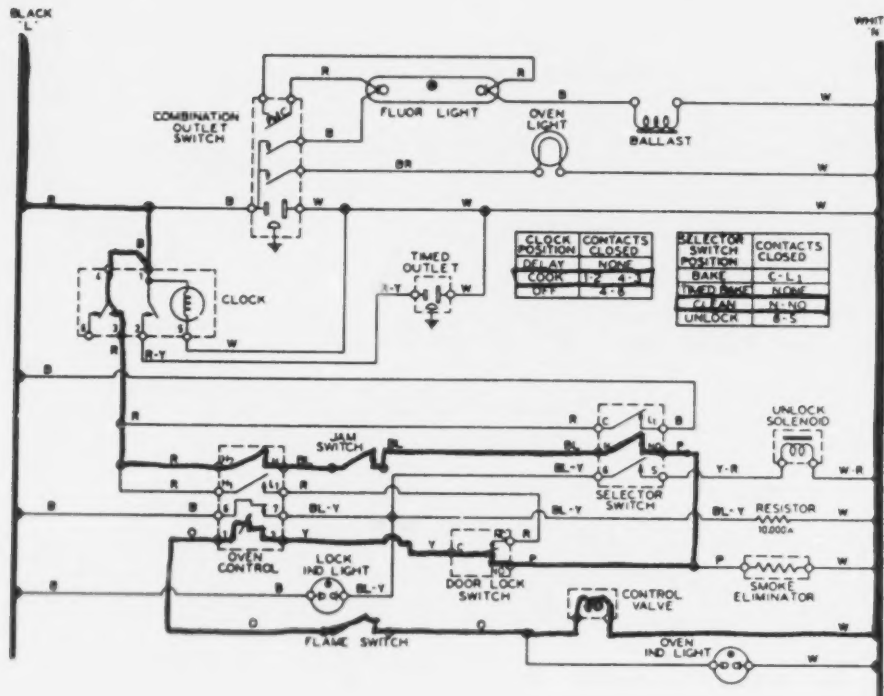
Assignment 3

- E. With the electric supply unplugged, the VOM set to read resistance, and the meter leads on Terminal 1 of the oven control and the purple wire to the left of the smoke eliminator, what will the resistance reading be?

Answer: About 150 Ω About 600 Ω About 900 Ω

Assignment Sheet 3

MAR-457



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**Gas Ranges and Ovens
Unit 12****Assignment Sheet 4—Determine Voltage and Resistance Readings
on a Self-Cleaning Gas Oven During Lock and Unlock**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Number of answers attempted	_____
Numbers of answers correct	_____

Directions: Refer to the schematic that accompanies this assignment. Assume that you are working with a VOM. Circle the correct answer to each of the following problems.

- A. If your VOM is set to read voltage and the meter leads are on Terminal 1 of the clock and the white wire to the right of the unlock solenoid, what voltage would the meter indicate?

Answer: 0 volts 120 volts 240 volts

- B. With the VOM still set to read voltage and the meter leads on Terminal 1 of the clock and Terminal 6 of the selector switch, and assuming oven temperature has reached 540°F, what voltage would the meter indicate?

Answer: 0 volts 120 volts 240 volts

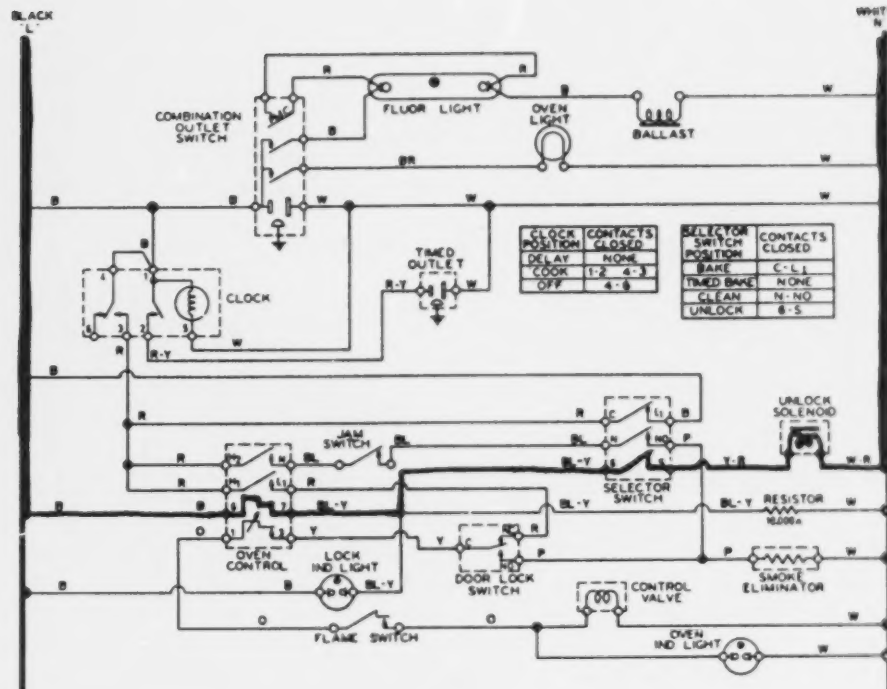
- C. With the electric supply unplugged, the VOM set to read resistance, and the meter leads on Terminal 3 on the clock and the white wire, what will the resistance reading be?

Answer 0 Ω 50 Ω 100 Ω

- D. With the electric supply unplugged, the VOM set to read resistance, and the meter leads on Terminal 3 of the oven control and Terminal L, of the oven control, what will the resistance reading be?

Answer: 0 to 5 Ω 10 to 20 Ω 100 to 110 Ω

Assignment Sheet 4



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**Gas Ranges and Ovens
Unit 12**

**Job Sheet 1—Install a Gas Range Level and Free
With All Burners Properly Adjusted**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Installation area inspected for safety and air supply	_____
All fittings correctly made and cut-off valve installed	_____
Range checked for level	_____
Gas supply to range and oven checked for leaks	_____
Range and oven burners checked and pilots left lit	_____

A. Tools and materials

Range as selected by instructor
Flexible connector (plastic coated, AGA approved)
Adjustable wrench (12")
Pipe wrench for backup (12" to 14")
Cut-off valve
Level
Safety glasses

B. Procedure

- ☐ 1. Put on safety glasses and turn off main gas supply.

Caution: If turning off the main gas supply will also cut off gas to other appliances, turn off the pilots to those other appliances BEFORE turning off the main gas supply.

- ☐ 2. Inspect area where range will be installed to make sure it will have sufficient air supply and not be near combustible materials.
- ☐ 3. Position range in approximate area of installation, but leave room enough behind to install connection.

Job Sheet 1

- ☐ 4. Dope the threads on the gas inlet line.
- ☐ 5. Install cut-off valve using an adjustable wrench on the cut-off valve and using a pipe wrench as a backup on the inlet line.

Note: Apply dope only to the threads on the inlet line, not to the interior threads of the brass cut-off fitting.

- ☐ 6. Make up the fitting between the cut-off valve and the flexible hose with an adjustable wrench on the flex hose connector and an open end wrench as a backup on the cut-off valve.

Note: Remember that on a residential installation, a flexible connector may not meet local codes, so be sure to check with the local building inspector.

- ☐ 7. Determine if the fitting on the range manifold requires a reducer or an expander from the flex hose and select the appropriate fitting as required.
- ☐ 8. Make up the fitting between the flex hose and the range manifold with an adjustable wrench.

Note: The manifold should be securely bolted down and not require a backup wrench.

- ☐ 9. Check to make sure the range is level.

Note: If you are ever caught without a level, a dish or container with a ring around it can be filled with water and used as a level.

- ☐ 10. Turn on the main gas supply.

Caution: Make sure there is not open flame around the range area, and remember that smoking while working around gas appliances is STRICTLY FORBIDDEN.

- ☐ 11. Purge the line by turning on an upper burner control until you detect the odor of gas, and then turning it off.

Note: This will bleed all air out of the gas line.

- ☐ 12. Brush leak detector on each fitting that you made and watch for bubbles that would indicate a leak.
- ☐ 13. Tighten any connection that shows evidence of leaking, and test again.
- ☐ 14. Make sure there are no leaks, and then test each top burner for a proper gas supply.

Job Sheet 1

- ☐ 15. Test the oven burner for a proper gas supply.
- ☐ 16. Observe flame at each burner, and adjust air shutter as required to produce a blue flame with a well defined inner cone of about $\frac{1}{2}$ " and a total flame height of about 1 $\frac{1}{2}$ ".
- ☐ 17. Turn off all burners after adjustment.
- ☐ 18. Make a final check for each burner to make sure it ignites when turned on and that the flame is properly adjusted.
- ☐ 19. Have your instructor check your work.
- ☐ 20. Relight all pilot lights that were turned off.
- ☐ 21. Clean up area and return tools and equipment to proper storage.

Comments _____

Gas Ranges and Ovens
Unit 12

**Job Sheet 2—Check Gas Oven Temperature for Proper
Oven Thermostat Settings**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Temperature probe correctly positioned	_____
Oven checked and thermostat calibrated for 250°F	_____
Oven checked and thermostat calibrated for 300°F	_____

A. Tools and materials

Range as selected by instructor

Temperature tester (Robinaire, Universal Instruments, or equivalent)

Safety glasses

B. Procedure

- ☐ 1. Put on safety glasses and turn off main gas supply.
- ☐ 2. Clip the tester probe to the center portion of the center rack in the oven.
- ☐ 3. Set the oven thermostat and preheat to 250°F so the oven liner will be properly heated.

Note: Always start a temperature check at a low oven setting because starting with a high setting would waste time while the oven cools off.

- ☐ 4. Position yourself so you can observe the oven flame.
- ☐ 5. Compare the temperature on the tester with the temperature on the oven thermostat at the moment the oven flame cuts back to the pilot:
 - (a) if the two readings are within 15°F high or low, the oven temperature is okay.

Job Sheet 2

- (b) if the two readings are beyond the 15°F limit, recalibrate the oven thermostat as outlined in a later job sheet.

Note: The temperature differential in some ovens may be higher than the 15°F listed above, so always check manufacturer's specifications.

- ☐ 6. Advance oven thermostat to 300°F and make temperature/thermostat checks as previously outlined.
- ☐ 7. Advance oven thermostat to 400°F and make temperature/thermostat checks as previously outlined.
- ☐ 8. Have your instructor check your findings.
- ☐ 9. Turn oven off and leave the door open so the oven will cool faster.
- ☐ 10. Prepare for recalibration of the oven thermostat or clean up area as directed by your instructor.

Comments _____

**Gas Ranges and Ovens
Unit 12**

MAR-469

Job Sheet 3—Recalibrate a Gas Oven Thermostat to Correct Settings

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Equipment set up correctly and correct option selected	_____
D-stem and pin type thermostat correctly calibrated (option)	_____
Thermostat w/recessed calibration screw properly calibrated (option)	_____
Thermostat w/dial shaft adjustment properly calibrated (option)	_____

A. Tools and materials

Range as selected by instructor
Temperature tester (Robinaire, Universal Instruments, or equivalent)
Longshank, extra-slender screwdriver
Needlenose pliers
Inspection light
Safety glasses

B. Routine 1—Set up equipment

- ☐ 1. Put on safety glasses.
- ☐ 2. Complete oven temperature test as previously outlined to make sure recalibration is required.
- ☐ 3. Permit oven to cool.
- ☐ 4. Clip the tester probe to the center portion of the center rack in the oven.
- ☐ 5. Set the oven thermostat to 250°F.
- ☐ 6. Position yourself so you can observe the oven flame.
- ☐ 7. Compare the tester temperature with the temperature of the oven thermostat setting the moment the oven flame cuts back to pilot.
- ☐ 8. Record your finding: _____

Job Sheet 3

- ☐ 9. Determine if the thermostat needs to be increased to raise oven temperature or decreased to lower oven temperature.
- ☐ 10. Determine type of thermostat and adjustment required:
 - (a) if the thermostat has a D-stem with a pin that has to be removed, follow instructions in Routine 2.
 - (b) if the thermostat has a recessed calibration screw, follow instructions in Routine 3.
 - (3) if the thermostat has a dial shaft adjustment, follow instructions in Routine 4.

C. Routine 2—Adjust a thermostat with a D-stem and pin (Figure 1)

- ☐ 1. Remove the control knob by pulling out.
- ☐ 2. Remove the bezel.
- ☐ 3. Make sure the D-stem does not move in either direction.
- ☐ 4. Use the needlenose pliers to remove the holding pin at the face of the calibration plate.
- ☐ 5. Insert a pocket screwdriver blade into the D-stem adjustment screw.
- ☐ 6. Follow instructions on the calibration plate to raise or lower temperature as required:
 - (a) to increase temperature follow arrow direction counterclockwise to raise to a higher (H) temperature.
 - (b) to decrease temperature follow arrow direction clockwise to a lower (L) temperature.
 - (c) each notch on the calibration plate indicates an increment of 25°F.
- ☐ 7. Complete recalibration for oven thermostat at 250°F.
- ☐ 8. Put D-stem pin back in place and return the bezel and thermostat control knob.
- ☐ 9. Open oven door and permit oven to cool down a bit.

Job Sheet 3

- ☐ 10. Make a second oven temperature check and record your findings:
 - (a) if the reading is a bit low, do not recalibrate until you make temperature checks at 300°F and 400°F.
 - (b) if the reading is a bit high, wait until other temperature checks are made before recalibrating.
- ☐ 11. Take temperature checks at 300°F and at 400°F and record your findings:
 - (a) if the 400°F thermostat setting is within 25°F of the oven temperature test, the thermostat is okay.
 - (b) if the 400°F thermostat setting is beyond or below the 25°F limit, then recalibrate as outlined previously.

Note: Exact calibration is seldom possible, but if the lower and upper temperature settings are relatively close, the mid-range temperature will probably be okay and a recalibration at 300°F will not be required.

- ☐ 12. Put the D-stem pin, bezel, and control knob back in place.
- ☐ 13. Have your instructor check your work.

D. Routine 3—Adjust a thermostat with a recessed calibration screw (Figure 2)

- ☐ 1. Make a 250°F temperature test as previously outlined.
- ☐ 2. Remove thermostat knob.
- ☐ 3. Insert a longshank, slender screwdriver down the D-stem shaft until the blade engages the calibration screw.
- ☐ 4. Turn the calibration screw counterclockwise to increase temperature or clockwise to decrease temperature.

Note: The basic difference between this type of control and the previous one is that there is no bezel and no D-stem pin to remove and replace.

- ☐ 5. Replace the thermostat knob and recheck thermostat setting at 250°F as previously outlined.
- ☐ 6. Make a temperature check at 400°F and recalibrate as required.
- ☐ 7. Record your findings.
- ☐ 8. Have your instructor check your work.

Job Sheet 3

E. Routine 4—Adjust a thermostat with a dial shaft adjustment (Figure 3)

- ☐ 1. Make sure the standby pilot is lit.
- ☐ 2. Turn dial counterclockwise to 550°F.
- ☐ 3. Permit oven burner to stay on for five minutes.
- ☐ 4. Turn dial back until it is mid-way between LO and OFF, and turn dial slightly either way until you observe a full heater pilot flame.
- ☐ 5. Use a screwdriver to turn the by-pass adjuster until flames over the entire burner are approximately 1/8" high.

Note: The by-pass flame adjustment should be made before recalibration is attempted.

- ☐ 6. Clip the temperature tester onto the center rack in the center of the oven.
- ☐ 7. Set dial to the LO mark and light the oven burner.

Note: The oven will snap on and off between LO and 325°F, and there should be no by-pass flame on the burner.

- ☐ 8. Watch as burner snaps on and off, and when it snaps on and stay on, make an oven temperature check.
- ☐ 9. Record your finding: _____.
- ☐ 10. Recalibrate only if the temperature check is more than 15°F above/below the dial marking of 140°F.
- ☐ 11. Insert a screwdriver in the screw of the calibration stem, and push the stem inward.
- ☐ 12. Hold the stem firmly in and turn the stem clockwise to obtain a lower temperature or counterclockwise to obtain a higher temperature.

Note: Calibration marks are in increments of 25°F.

- ☐ 13. Replace dial assembly.
- ☐ 14. Turn oven off, open door, and let oven cool about ten minutes.
- ☐ 15. Make another temperature check as previously outlined to make sure recalibration is proper.
- ☐ 16. Record your findings.

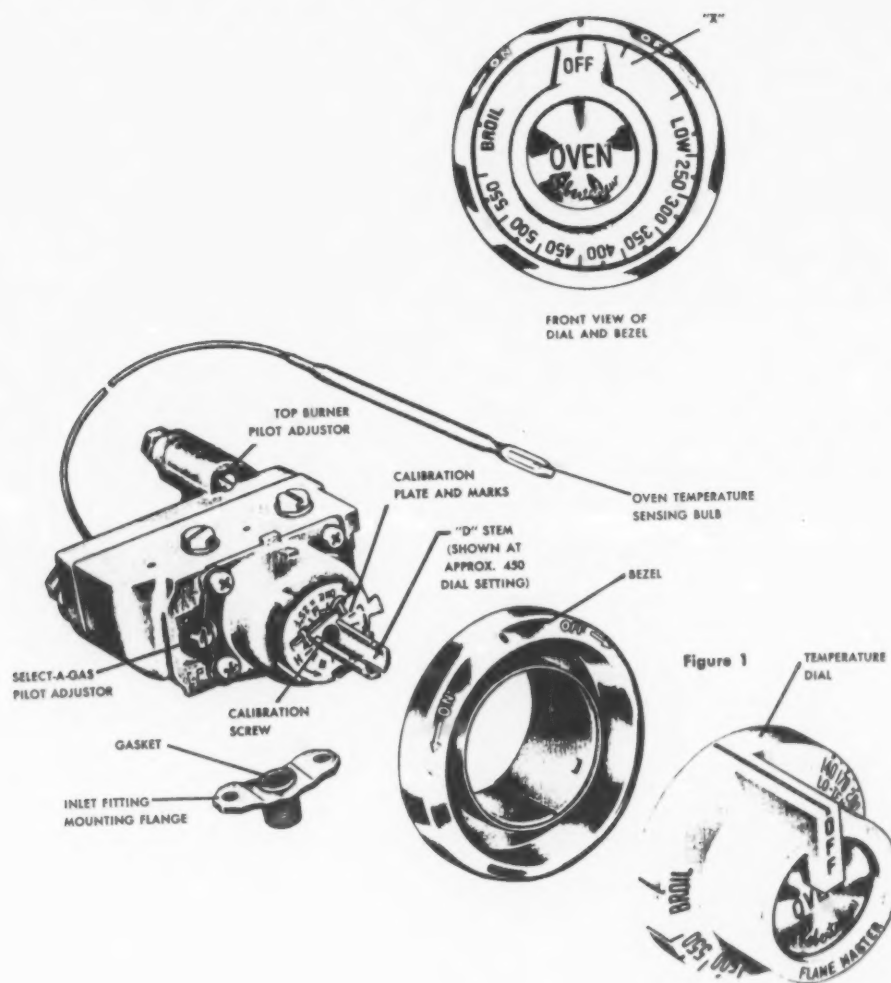
Job Sheet 3

- ☐ 17. Have your instructor check your work.
- ☐ 18. Clean up area and return tools to proper storage.

Comments _____

Job Sheet 3

Figure 1

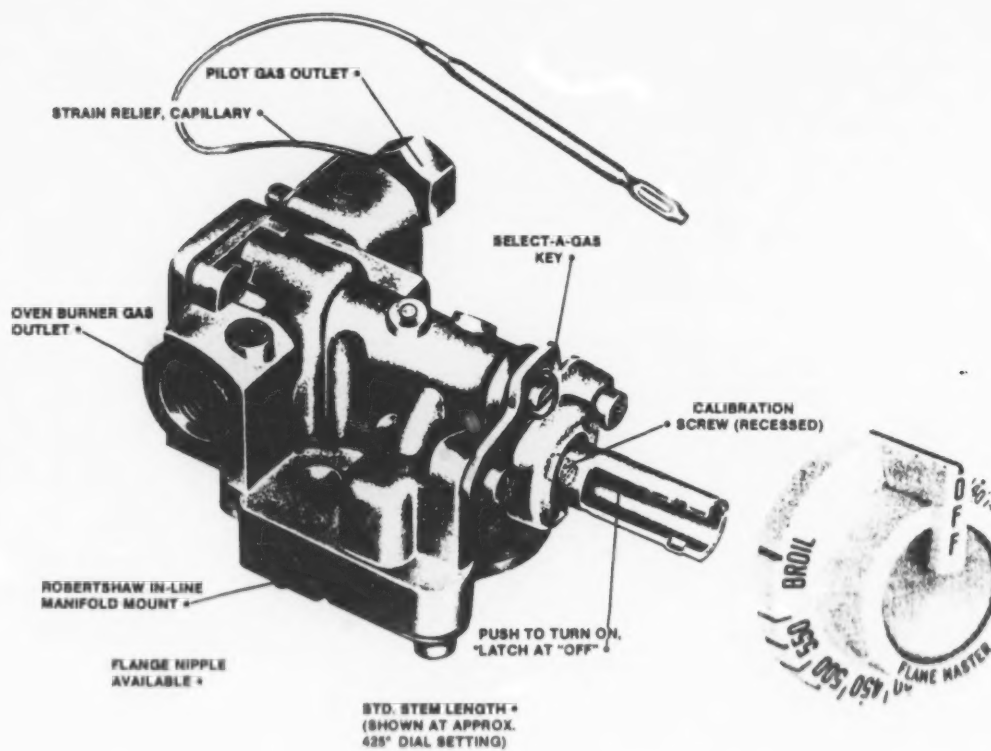


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747
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Job Sheet 3

Figure 2



748

Courtesy Robertshaw

Figure 3

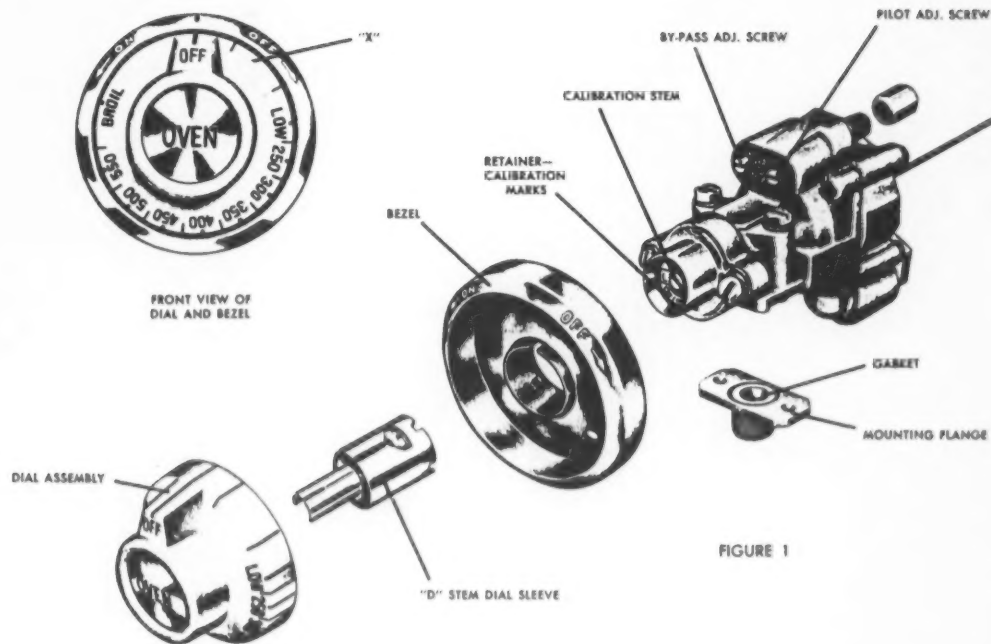


FIGURE 1

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Courtesy Robertshaw

**Gas Ranges and Ovens
Unit 12****Job Sheet 4—Remove, Disassemble, Clean, Lubricate, and Reassemble
a Standard Gas Burner Valve**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Control knob and front panel removed for access	_____
Valve stem accessed and removed correctly	_____
Stem and stem interior correctly cleaned	_____
Graphite lubricant applied and worked around stem	_____
Burner valve correctly reassembled	_____

A. Tools and materials

Range with standard gas burner valve
Pliers
Open-end or adjustable wrench
Clean shop towels
Graphite lubricant
Safety glasses

B. Procedure

- ☐ 1. Put on safety glasses.
- ☐ 2. Turn off gas supply to the oven.
- ☐ 3. Begin disassembly by removing the control knob from the burner valve.
- ☐ 4. Remove the front panel to gain access to the burner valve.
- ☐ 5. Remove burners to gain access to the burner valves, if you are working on that type of range.

Job Sheet 4

- ☐ 6. Use pliers to remove the knurled nut from the end of the valve body.

Caution: Watch for the spring behind the nut because it may fly out as you remove the nut.



- ☐ 7. Place the pliers on the valve control stem and work it back and forth gently until it comes out.



Job Sheet 4

- ☐ 8. Clean the cone-shaped stem with a clean shop cloth.
- ☐ 9. Clean the interior of the stem housing with a clean shop cloth.
- ☐ 10. Place graphite lubricant on the outside of the control stem and work it all around the stem with your finger.



- ☐ 11. Place the control stem back into the housing, and make sure the pin in the control stem fits into the cutout in the valve body.



Job Sheet 4

- ☐ 12. Put the spring back onto the end of the control stem.
- ☐ 13. Replace the knurled nut on the end of the control stem.
- ☐ 14. Work stem back and forth to make sure it is free and moving properly.
- ☐ 15. Repeat the same procedure for the other gas burner valves on the range.
- ☐ 16. Replace the front panel as required.
- ☐ 17. Replace all control knobs and burners.
- ☐ 18. Turn on the gas supply.
- ☐ 19. Check each valve for proper operation.
- ☐ 20. Have your instructor check your work.
- ☐ 21. Clean up the area and return tools and materials to proper storage.

Comments _____

Electric Ranges and Ovens

Unit 13

Objective Sheet



Unit Objective

After completing this unit, the student should be able to remove a surface element from an electric range and check for proper resistance, check the self-cleaning function on an electric oven, and make continuity checks on step-type and infinite electric range switches. The student should demonstrate these competencies by completing the activities in the job sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to electric ranges and ovens with their correct definitions.
2. Complete statements about electrical requirements for hooking up an electric range.
3. Select true statements about basics of electric cooking.
4. Solve problems about servicing electric surface and oven heating elements.
5. Differentiate between types of heat controls for surface heating elements.
6. Complete statements about types of electric oven thermostats.
7. Solve problems about recalibrating electric oven thermostats.
8. Solve problems about typical electric oven self-cleaning operation.
9. Match other components with their functions in a self-clean cycle.
10. Complete statements about troubleshooting electric ranges.
11. Check surface units from an electric range for proper resistance. (Job Sheet 1)
12. Check the self-cleaning function on an electric oven. (Job Sheet 2)
13. Check step-type and infinite electric range switches for continuity. (Job Sheet 3)

Electric Ranges and Ovens
Unit 13

MAR-487

Information Sheet

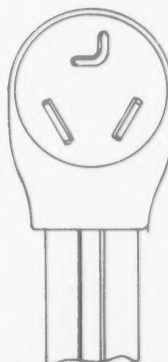
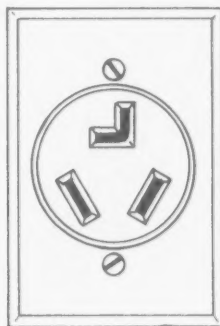
1. Terms and definitions

- a. **Catalyst**—A chemical or other substance used to speed up or slow down a process such as the platinum/paladium screens that cause smoke to burn at lower temperatures in self-cleaning ovens
- b. **Infinite controls**—Electric range switches that provide a user with limited heat selections by cycling voltage on and off
- c. **Recalibrate**—The procedure of adjusting a switch or control device so that it will perform to a specified standard
- d. **Step-type controls**—Electric range switches that provide a user heat selections in limited increments such as low, medium, and high by controlling voltage input only

2. Electrical requirements for hooking up an electric range

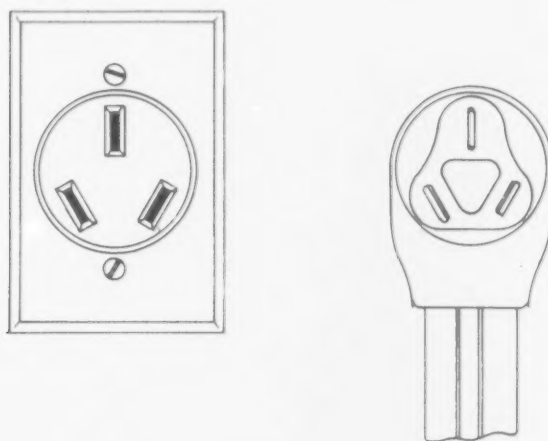
- a. To operate properly, electric ranges require 240V at 50 amps.
- b. Receptacles for electric ranges will accept only a three-prong or four-prong, straight-bladed plug.
- c. A dryer plug with an L-shaped blade should never be modified for use on an electric range because a dryer plug is designed for only 30 amps and has smaller conductor wires.

Caution: A modified dryer connection used on an electric range is a fire hazard, and any service person who runs into such a hookup should immediately inform the customer of the danger and advise that the hookup be changed.



Information Sheet

- d. Anything less than the proper 3-prong or 4-prong range hookup is in violation of the National Electric Code and state and local codes.



3. Basics of electric cooking

- a. Instead of being rated in BTU's, electric range heating elements are rated in watts.
- b. Both surface heating elements and oven heating elements are made from an alloy of nickel and chromium called nichrome.
- c. Heating elements have nichrome coils embedded in an insulated sheath, then covered with stainless steel tubing, a design that produces efficiency.

Note: Top surface heating elements have the tubing flattened on one side to provide a level surface for pots and pans, but oven elements are almost always tube-shaped.

- d. Electric ranges produce no byproducts of combustion.

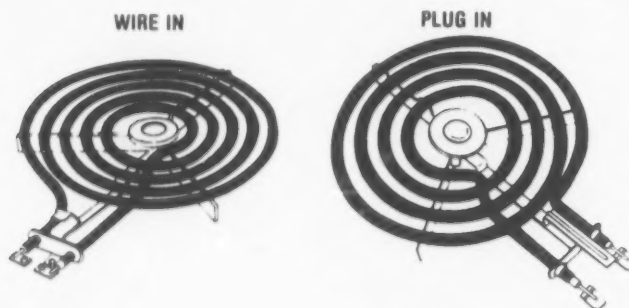
Note: Electric ranges with self-cleaning features are exceptions to the rule about byproducts; they usually have filtering devices to consume smoke produced in self-cleaning.

- e. Electric ranges are preferred appliances in areas where the cost of electricity is lower than the cost of gas.

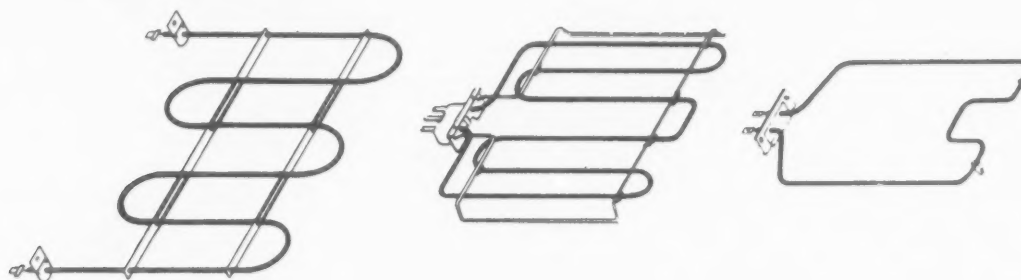
Note: Arguments about the advantages of electric cooking over gas cooking or vice-versa, usually boil down to which energy supply is least expensive because when preheat recommendations are followed, both types of ranges perform equally well.

4. Servicing electric surface and oven heating elements

- a. Both surface and oven elements usually plug directly into ceramic connections and may be connected with screw connections or spade connections.
- b. When there is a complaint of poor surface or oven heating, always check the connections first, and it is also good to check connections on any service call because a loose connection will impair performance and create a fire hazard.
- c. Surface elements are coil-shaped and may have single or double elements.



- d. Oven heating elements come in several shapes, but almost all have a single two-lead connection.



- c. A simple continuity check can determine if an element needs to be replaced, and replacement elements should always be of the same wattage as the original.

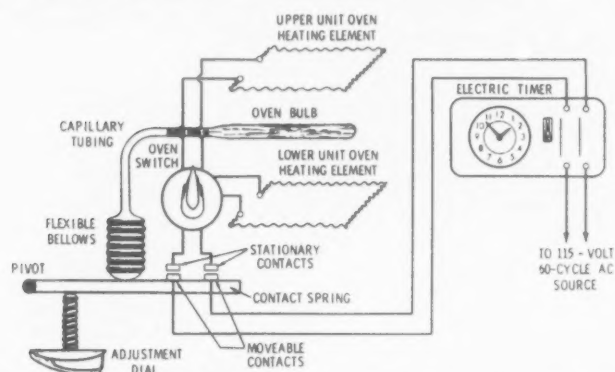
5. Types of heat controls for surface heating elements

- a. Step-type heat controls and characteristics:
 - (1) Step-type controls work by controlling voltage input only.
 - (2) Controls permit use of both 240V and 120V in such a way that the two voltages may work individually or together for precise heat control.
 - (3) Some step-type controls have as few as three heat settings: high, medium, and low.

6. Types of electric oven thermostats

a. Bellows type and characteristics:

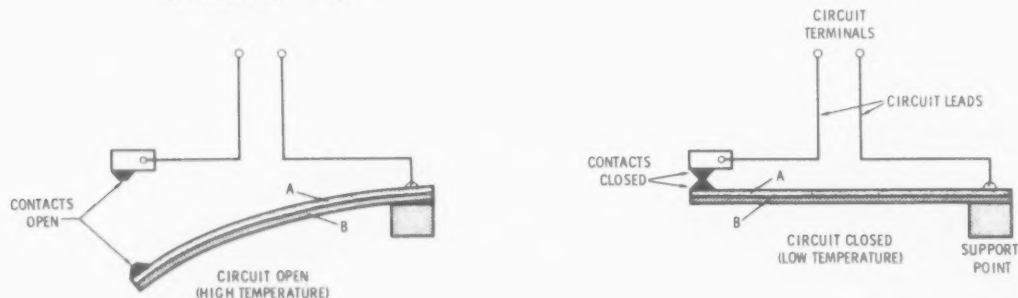
- (1) A bellows expands or contracts as silicon oil in a capillary tube expands or contracts.
- (2) As the bellows expands or contracts it opens or closes switch contacts which turn the oven heating element on or off.



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b. Bimetallic type and characteristics:

- (1) A strip made of two dissimilar metals flattens or arches in response to temperature changes, and opens and closes switch contacts.
- (2) As the switch contacts open and close, the oven heating element is turned on or off.

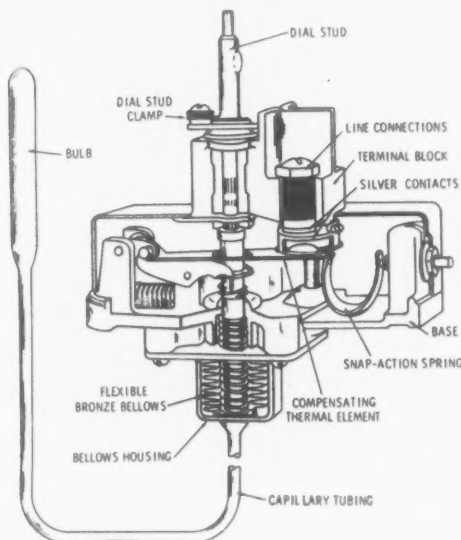


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Information Sheet

c. Diaphragm type and characteristics:

- (1) A diaphragm expands or contracts in response to pressure from a capillary tube.
- (2) The diaphragm activates or deactivates a click-action switch that turns the oven heating element on or off.



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7. Recalibrating electric oven thermostats

- a. Electric oven thermostats are calibrated at the factory and should not be tampered with unless a careful check of oven temperature indicates recalibration is required.
- b. Recalibration on most electric oven thermostats is accomplished by turning a small screw in the face of the thermostat to the left to increase oven temperature or to the right to decrease oven temperature.
- c. Recalibration should always be followed with a second oven temperature test to assure the new settings are correct.
- d. Newer ovens require only a simple knob adjustment.

8. Typical electric oven self-cleaning operation

Note: The wiring schematics in Student Supplement 1 should be referenced as needed to relate circuit operations to steps in the clean cycle.

- a. The operation starts when the CLEAN button on the selector switch is pushed:
 - (1) The internal heat element is placed in series with the broil element through switch contacts "BR" and "EX1" which close.
 - (2) At the same time, "BK" and "EX2" contacts close completing a circuit between the external front frame element and the bake element, and this places the bake element in parallel with the broil element and internal heat element.
 - (3) As all of the above takes place, the switch contacts close from "P1" to "CL" and from "HL" to "NO".
- b. Setting the control knob on the clock timer to LIGHT CLEAN or HEAVY CLEAN will:
 - (1) Close the contacts between terminals "1" and "3" on the clock timer switch.
 - (2) Break the circuit at terminal "2".
 - (3) Prevent operation of the right rear surface unit and oven light during the clean cycle.
- c. Pushing the LOCK lever all the way to the right will:
 - (1) Close the switch contacts "C" to "NO" on the Door Latch Switch.
 - (2) Complete the low voltage circuit through the secondary windings of the transformer across terminals "HL" and "NO" on the selector switch, and through the Hi Limit Switch and across terminals "S" and "A" on the oven thermostat.
- d. Applying 12-volt current to the "Hot Wire Relay" on the back of the oven thermostat will:
 - (1) Cause the relay switch contacts between terminals "L" and "H" in the Hi-Voltage side of the relay to close.
 - (2) Complete a circuit across all heat elements.
 - (3) Cause the "OVEN ON" indicator light to come on.

Information Sheet

- e. When oven temperature rises to approximately 550°F:

Note: Be sure to reference Student Supplement 1 so you will have a complete understanding of what control circuitry takes over as oven heat increases.

- (1) The bimetallic thermal unit in the door lock switch raises the locking screw into position so that the lock lever cannot be moved.
- (2) At the same time, contacts in the switch are closed to complete a circuit to the lock indicator light.

- f. When oven temperature increases to 825°F to 1100°F:

- (1) The HI LIMIT SWITCH opens.
- (2) The low voltage circuit to the Oven Thermostat is now broken causing the Hot Wire Relay to cool.
- (3) This causes the relay switch contacts in the high voltage circuit to open.

- g. When oven temperature decreases to about 825°F:

- (1) The HI LIMIT SWITCH closes.
- (2) The oven goes through a temperature rise once again until the HI LIMIT SWITCH opens at somewhere beyond 825°F.
- (3) The cycle is repeated until the Clock Timer runs through the programmed CLEAN time.

- h. When programmed time expires:

- (1) The Clock Timer Switch contacts break at terminal "Z" and the oven starts cooling.
- (2) The oven cools and the right rear surface unit can be used.

- i. When the oven cools to 250°F to 325°F:

- (1) The thermal unit in the Door Lock Lever cools.
- (2) This permits the Door Lock Lever to be moved manually to the left.
- (3) At the same time the lock light goes out, the clean cycle is complete, and the oven door may be opened.

9. Other components and their function in a self-clean cycle

- a. **Metal mesh oven window screen**—Must be pulled in place over the oven window before the oven door can be latched shut
- b. **Lock latch**—A mechanical latch that must be pushed to the far right in order for the self-cleaning function to be started.

Note: Do not confuse this mechanical lock with the interior lock that snaps into place after the oven reaches about 550°F; the interior lock backs up the mechanical lock for added safety.

- c. **Smoke eliminator**—A filter-type screen coated with a platinum/paladium combination and then oxidized to act as a catalyst which causes smoke to burn at a lower temperature.

Note: Smoke eliminators are usually mounted to the oven top directly under the right rear surface unit.

10. Troubleshooting electric ranges

- a. When the oven will not heat or when the oven will not turn off, check for:
 - (1) a blown fuse,
 - (2) loose wire(s),
 - (3) selector switch problems,
 - (4) timer problems,
 - (5) defective thermostat,
 - (6) defective bake element, or
 - (7) control circuitry problems.
- b. When a surface unit will not heat, is always on high, or has too much heat on a low setting, check for:
 - (1) a blown fuse,
 - (2) loose or incorrect connection,
 - (3) an open in the element itself, or
 - (4) bad surface unit switch.

Information Sheet

- c. When a timer appears to be malfunctioning, check for:
- (1) loose connections or wrong connections (check wiring schematic),
 - (2) bad timer motor, or
 - (3) bad timer.
- d. When an oven door does not close properly, check for:
- (1) Worn pins or hinge brackets, or

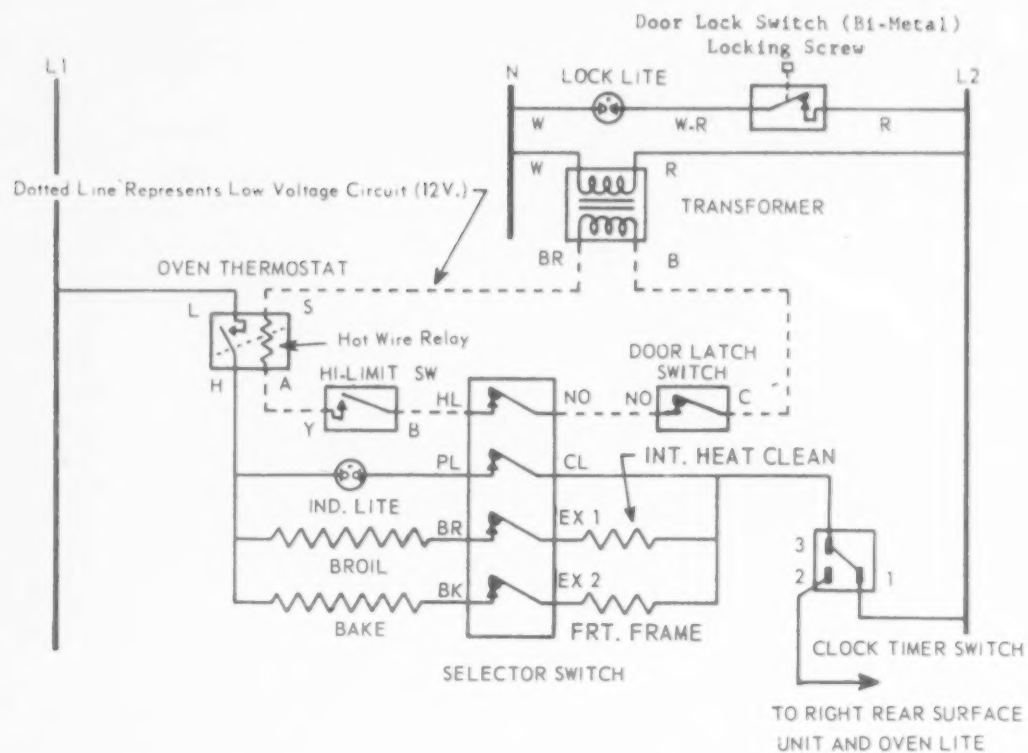
Note: As heat pressure builds up, oven liner expansion could cause the door to come open while the oven is baking.
 - (2) Problems with the oven door seal or misalignment.

Note: This might actually cause the oven to sweat, and could also suggest a clogged vent or the need for recalibrating the oven thermostat.
- e. When a self-cleaning function does not operate, check for:
- (1) problems with bake and broil circuitry,

Note: This requires a wiring schematic.
 - (2) problems with selector switch or oven thermostat,
 - (3) blown fuse, or
 - (4) problems with the safety interlock system.

Electric Ranges and Ovens Unit 13

Student Supplement 1—Schematics and Diagrams

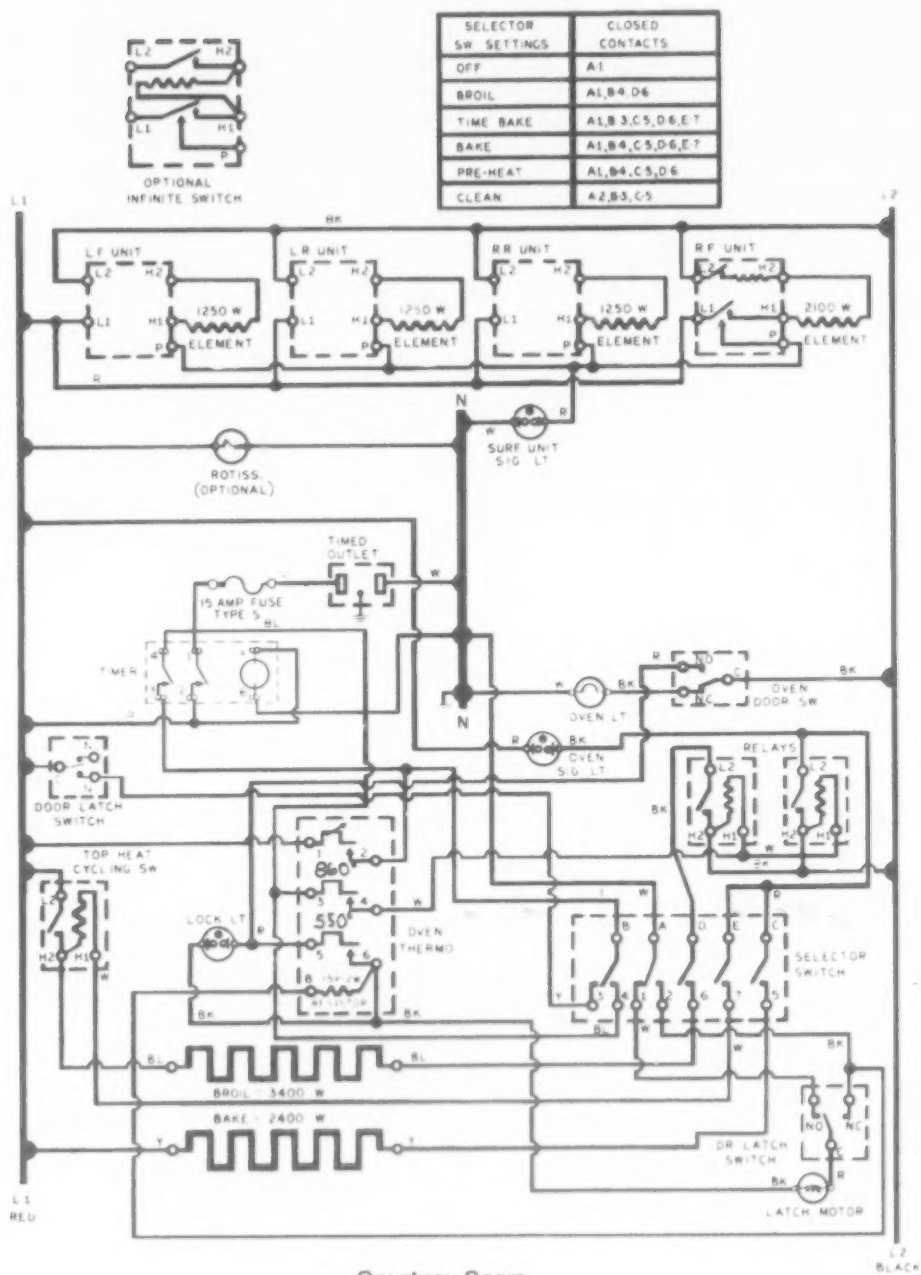


Courtesy Sears

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Student Supplement 1

Electric Range Wiring Diagram



Courtesy Sears

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Electric Ranges and Ovens
Unit 13

**Job Sheet 1—Check Surface Units From an Electric Range for
Proper Resistance**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Surface unit safely removed	_____
Surface unit inspected	_____
VOM resistance readings completed for all units	_____

A. Tools and materials

Electric range as selected by instructor
VOM
Standard and Phillips screwdrivers
Shop cloth
Pencil and paper
Wire brush and fine sandpaper
Safety glasses

B. Procedure

- ☐ 1. Put on safety glasses.
- ☐ 2. Unplug the range from its power supply and permit top elements to cool if recently used.
- ☐ 3. Make a visual inspection of the ceramic receptacles that the surface elements are plugged or wired into, and check with your instructor to see if damage or wear may require special service.
- ☐ 4. Clean connections as needed with a shop cloth, fine sandpaper, or lightly with a wire brush to make sure your VOM probes will make good contact.
- ☐ 5. Set the VOM to the lowest resistance scale and cross the leads to zero the meter.
- ☐ 6. Place one lead on each terminal of the right front surface element.
- ☐ 7. Record the reading on the resistance check worksheet on the following page.

Job Sheet 1

- ☐ 8. Make and record resistance readings for the rest of the surface units.
- ☐ 9. Have your instructor check your readings.
- ☐ 10. Clean up area and return tools and VOM to proper storage.

Comments _____

Job Sheet 1

Name _____ Date _____

Surface Unit Resistance Checks

Right front unit: _____

Left front unit: _____

Right rear unit: _____

Left rear unit: _____

Note: Compare your readings with manufacturer's specifications or the correct resistance readings as supplied by your instructor. Check "okay" or note variations below.

Right front unit: okay ☐ variation: _____Left front unit: okay ☐ variation: _____Right rear unit: okay ☐ variation: _____Left rear unit: okay ☐ variation: _____

Electric Ranges and Ovens
Unit 13

MAR-503

Job Sheet 2--Check the Self-Cleaning Function on an Electric Oven

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Oven properly prepared for self-clean cycle	_____
Self-clean cycle start and finish timed and recorded	_____
Smoke eliminator verified as functioning	_____

A. Tools and materials

Electric range w/self-cleaning oven
Shop cloth
Pencil and paper
Clock or watch for timing cycle
Safety glasses

B. Procedure

- ☐ 1. Put on safety glasses.
- ☐ 2. Make sure range is plugged into a proper power supply.
- ☐ 3. Check oven door or console face for self-cleaning instructions.



Job Sheet 2

- ☐ 4. Open the oven door and manually raise the mesh screen protector over the door.



- ☐ 5. Close the oven door and manually lock it into place.



- ☐ 6. Set the oven controls for the self-cleaning cycle as directions indicate.



- ☐ 7. Write down the time the cycle begins: _____
- ☐ 8. Monitor heat on the outside of the oven door by placing your hand close to the door surface, but **DO NOT PUT YOUR FACE NEAR THE OVEN DOOR OR ATTEMPT TO LOOK INSIDE THE OVEN.**
- ☐ 9. Continue to monitor the oven for indication that the smoke eliminator is functioning properly:
- a. in some ranges, a fan will come on and a lock switch light will go on to indicate the smoke eliminator has been activated.
 - b. in some ranges, the only evidence that the smoke eliminator is working will be hot air rising from the right rear burner.
 - e. if some comes out of the right rear burner along with the hot air, it means the platinum/paladium screen filter is not working and needs to be replaced.

Caution: Do not open the oven door until the oven has cooled off.

- ☐ 10. When oven completes the self-clean cycle, record finish time: _____
- ☐ 11. Compare your recorded time with the preset time you set on the self-clean clock mechanism, and if the two are off, it may indicate a malfunction and require further testing.
- ☐ 12. Permit the oven to cool down.
- ☐ 13. Check the results of the self-clean cycle to make sure the oven is clean.

Job Sheet 2

- ☐ 14. Use a shop cloth to wipe away any ash residue left in the oven.
- ☐ 15. Have your instructor check your work.
- ☐ 16. Clean up area and return tools and materials to proper storage.

Comments _____

Electric Ranges and Ovens
Unit 13

MAR-507

Job Sheet 3—Check Step-Type and Infinite Electric Range Switches
for Continuity

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
All switches checked for proper cycling	_____
All switches checked for full 360° operation	_____
Schematics used or drawings sketched as needed	_____

A. Tools and materials

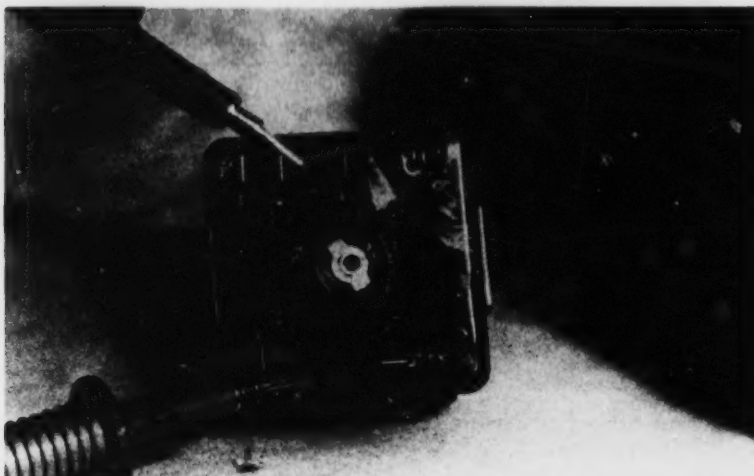
Electric range as selected by instructor
VOM
Repair technician's hand tools
Temperature tester w/griddle probe
Shop cloth
Pencil and paper
Safety glasses

B. Routine 1—Check an infinite switch

- ☐ 1. Put on safety glasses.
- ☐ 2. Unplug the range from its power supply.
- ☐ 3. Remove the front panel or console so you can reach all switches.
- ☐ 4. If there is no schematic available, draw a sketch and note each wire and which terminal it goes to on the switch.
- ☐ 5. Remove the leads from the switch terminals.
- ☐ 6. Unbolt or unscrew the switch, remove it, and place it on a clean working surface.
- ☐ 7. Inspect the switch to make sure the bus bar running diagonally from the "H1" terminal has not burned out; if the bus bar is burned out it will be dislodged from its normal position and easy to detect.

Job Sheet 3

- ☐ 8. If the bus bar is bad, replace the entire switch, and if the bus bar is okay, continue troubleshooting.
- ☐ 9. Set the VOM on the R x 1 scale for measuring resistance.
- ☐ 10. Place one VOM probe on the "L1" terminal of the switch and the other probe on the "H1" terminal.



- ☐ 11. Rotate the switch control stem a full 360° and record the VOM readings each time the switch clicks:

Readings: _____

- ☐ 12. If no reading is evident, the switch is bad and should be replaced, but if readings range from 2 to 5 ohms, the switch is okay.
- ☐ 13. Use a temperature tester with a griddle probe to conduct a cycling test to make sure the switch is cycling the surface unit off and on.

Note: If a griddle probe is not available, a cycling test can also be conducted with a pan of water and a regular thermometer.

- ☐ 14. Replace the switch in the range and turn the range ON.
- ☐ 15. Hold the griddle probe on a surface unit, and turn the infinite switch to its first setting.

Job Sheet 3

- ☐ 16. If the meter indicates a low temperature reading, and if the reading then drops off, the surface unit is cycling on low heat.
- ☐ 17. If there is not a temperature reading, the switch is not cycling and the surface unit and the switch should both be replaced.
- ☐ 18. If the temperature reading goes beyond a low reading, and does not cycle off, the switch is bad and should be replaced.
- ☐ 19. Repeat the procedure for medium and high heat positions, and replace the switch if any of the readings are improper.
- ☐ 20. Have your instructor check your work.

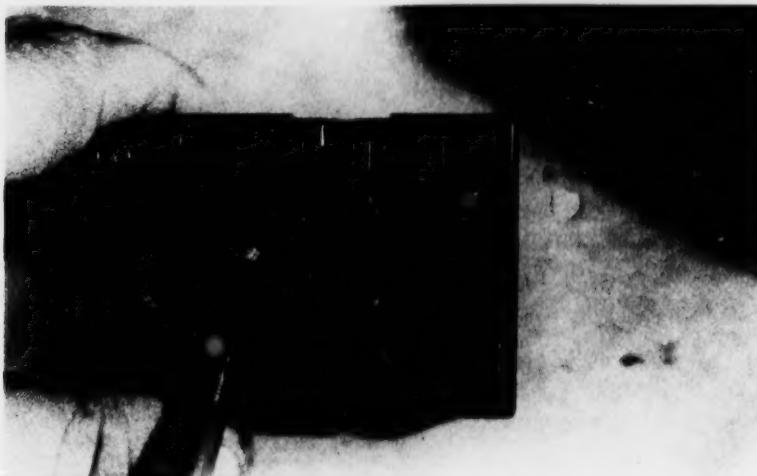
C. Routine 2—Check a step-type switch

- ☐ 1. Put on safety glasses.
- ☐ 2. Remove front console or access panel so you can reach the switches.
- ☐ 3. Draw a sketch of the switch you plan to check and note the position of each wire and the terminal it goes to on the switch.
- ☐ 4. Remove the leads from the switch terminals.
- ☐ 5. Unbolt or unscrew the switch, remove it from the range, and place it on a clean working surface.
- ☐ 6. Set the VOM on the R x 1 scale for measuring resistance.
- ☐ 7. Place VOM probe on the power input terminal.

Note: Step 7 may require a schematic; check with your instructor.

Job Sheet 3

- ☐ 8. Place the other probe on any other terminal and keep moving the probe from one terminal to another until you get a reading on the VOM.



- ☐ 9. Rotate the switch control stem a full 360° and record the readings on the VOM each time the switch clicks:

Readings: _____

- ☐ 10. If no readings are evident, the switch is bad and should be replaced; if the readings are as low as infinity or range from 2 to 5 ohms, the switch is okay and should be reinstalled on the range.
- ☐ 11. Repeat the procedure for all step-type switches on the range.
- ☐ 12. Have your instructor check your work.
- ☐ 13. Clean up area and return tools and materials to proper storage.

Comments _____

Microwave Ovens

Unit 14

Objective Sheet



Unit Objective

After completing this unit, the student should be able to test the interlock on a microwave oven; check for microwave leakage with an RF test probe; conduct power tests; remove and replace a blower motor; test and replace a magnetron; and test and replace a low voltage transformer and triac. The student should also complete other service and inspection as assigned. The student should demonstrate these competencies by completing the activities in the job sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to microwave ovens with their correct definitions.
2. Complete statements about microwaves and microwave ovens.
3. Match microwave oven controlling standards with their controlling agencies.
4. Select true statements about the performance standard for microwave ovens.
5. Select true statements about FCC microwave standards.
6. Match basic components with their functions in a microwave oven.
7. Complete statements about magnetron structure and operation.
8. Complete statements about the significance of microwave reflection.
9. Complete statements about the significance of microwave transmission.
10. Complete statements about the significance of microwave absorption.
11. Arrange in order the steps in microwave cooking.
12. Arrange in order the steps in installing a microwave oven.
13. Select true statements about general rules for preventive maintenance.
14. Match major microwave oven components with their functions.

Objective Sheet

15. Select true statements about requirements for RF leakage test instruments.
16. Complete statements about spacer cones.
17. Match operating controls with their functions.
18. Complete statements about motors in microwave ovens.
19. Select true statements about door seals and their importance in microwave oven construction.
20. Complete statements about technical materials required for microwave oven service.
21. Arrange in order the steps in troubleshooting a microwave oven.
22. Complete statements about pre-service inspection requirements for microwave ovens.
23. Complete statements about safety requirements for microwave oven service.
24. Complete statements about post-service safety requirements.
25. Test the interlock system on a microwave oven for safe operation. (Job Sheet 1)
26. Check an RF leakage test meter and check a microwave oven for RF leakage. (Job Sheet 2)
27. Clean and deodorize a microwave oven. (Job Sheet 3)
28. Determine if selected utensils are microwave safe. (Job Sheet 4)
29. Discharge a capacitor. (Job Sheet 5)
30. Check stirrer blade rotation and remove and disassemble a stirrer system. (Job Sheet 6)
31. Replace and adjust a microwave oven door assembly. (Job Sheet 7)
32. Conduct power tests on a microwave oven to check for temperature rise under full power. (Job Sheet 8)
33. Test and replace high voltage components when an oven produces little or no heat. (Job Sheet 9)

Objective Sheet

34. Remove a blower motor and transformer and remove and reinstall a magnetron. (Job Sheet 10)
35. Check the interlock switch module on a microwave oven. (Job Sheet 11)
36. Test and replace magnetron and cavity thermal protectors. (Job Sheet 12)
37. Test and replace a low voltage transformer and a triac module. (Job Sheet 13)
38. Test a temperature probe and probe jack. (Job Sheet 14)
39. Test and replace an oven timer and an oven controller. (Job Sheet 15)
40. Remove, test, and replace a control board. (Job Sheet 16)
41. Test a control circuit board. (Job Sheet 17)
42. Test a cook relay. (Job Sheet 18)
43. Test and replace a turntable motor. (Job Sheet 19)

**Microwave Ovens
Unit 14**

Information Sheet

1. Terms and definitions

- a. **Arcing**—The generation of visible electrical sparks caused by microwaves striking and bouncing off objects with high metallic content
- b. **CFR (Code of Federal Regulations)**—A government document published at required intervals to provide the general public with printed copies of new federal regulations or changes in existing regulations
- c. **Condition**—A way of stating whether a microwave oven is idle or going through a cycle that will defrost, warm, or cook food
- d. **Cycle**—The time it takes a microwave oven to perform a defrost, warm, or cook operation
- e. **Diode**—A device that permits electricity to flow in one direction only
- f. **FCC (Federal Communications Commission)**—A government agency which assign and controls the use of electromagnetic frequencies
- g. **Load**—The liquid or food placed into a microwave oven so microwaves will be absorbed instead of reflected back into the oven components
- h. **Rectifier**—A device that converts normal household current into pulsating DC current
- i. **RF energy (Radio Frequency)**—A general reference to all forms of electromagnetic wavelengths including microwaves which have a frequency of 2450 MHz
- j. **The Standard**—An abbreviated reference to "The Federal Performance Standard for Microwave Ovens" contained in 21 CFR, Subchapter J

Information Sheet

2. Microwaves and microwave ovens

- a. Microwaves are waves of energy that are 4.8 inches long and as thick as a pencil.



- b. Microwaves are part of the electromagnetic spectrum that includes several forms of RF energy.

Non-Ionizing and Non-Cumulative															Ionizing and Cumulative						
2 10	3 10	4 10	5 10	6 10	7 10	8 10	9 10	10 10	11 10	12 10	13 10	14 10	15 10	16 10	17 10	18 10	19 10	20 10	21 10	22 10	
Music and Speech							AM/FM Radio and TV			Microwave Ovens		Infra-Red Rays		Visible Light Waves	Ultra-Violet Rays	X-Rays		Cosmic Rays			

- c. Microwaves are considered non-ionizing and non-cumulative rays because they do not pack the energy of ionizing rays such as X-rays, and their effects on the human body do not build up.
- d. Microwave ovens generate microwaves in a controlled process that permits ovens to rapidly thaw, warm, or cook food.

3. Microwave oven safety standards and their controlling agencies

- a. **Federal Communications Commission**—Limits the frequencies available for microwave oven operations so that they can operate without interfering with communications devices
- b. **Department of Health and Human Services**—Limits the acceptable amount of radiation that a microwave oven may emit and specifies door locks and monitoring system
- c. **Underwriters Laboratories**—Requires that microwave ovens subscribe to safety standards for operation as an electrical device

Note: The FCC and HHS regulations require specific labels be placed on a microwave oven at the time of manufacture, but the UL approval that appears on most labels is a voluntary option of the manufacturer.

4. The Performance Standard for Microwave Ovens

- a. The Performance Standard for Microwave Ovens applies to all microwave ovens manufactured after October 6, 1971.

Note: The standard is presented in detail by the Department of Health and Human Services, 21 CFR, Subchapter J, and the following materials cover the main parts of the standard only.

- b. Microwave emission shall not exceed 1 milliwatt per square centimeter at 5 cm (2") from the external surface of the oven prior to acquisition by the purchaser.
- c. Microwave emission shall not exceed 5 milliwatts per square centimeter at anytime during the life of the oven.
- d. Microwave ovens must have at least two safety interlocks, and one of the interlocks must be concealed.

Note: Most ovens designate these safety interlocks as primary or bottom interlock and secondary or upper interlock.

- e. The interlock system must include a monitor which will cause the oven to become inoperative if either interlock fails.
- f. RF leakage tests to determine microwave emission must be made with approved test instruments only.
- g. Precaution labels concerning use and service must be attached to a microwave oven.
- h. The label on a microwave oven must have the name and address of the manufacturer and the place of manufacturer.

Note: Some of these items may be coded.

5. FCC microwave standards

- a. Microwave ovens are assigned operating frequencies by the FCC so they will not interfere with other frequencies.
- b. Microwave frequencies include 915 MHz and 2450 MHz, but almost all modern countertop microwave ovens use the 2450 MHz frequency.

Note: The 915 MHz frequency was used in early microwaves, but it is rare to find a modern microwave oven that operates at 915 MHz.

- c. Other microwave frequencies do have specific FCC assignments, but these frequencies are reserved for ISM (industrial, scientific, and medical) applications.
- d. The label on a microwave oven must list the operating frequency of the oven and indicate FCC approval.

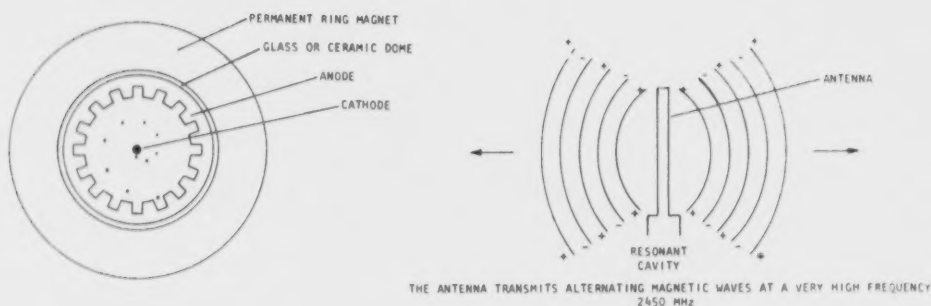
6. Basic components and their functions in a microwave oven

- a. **A microwave source**—This is usually a magnetron which generates microwaves and directs them from an antenna into a transmission device or an oven cavity
- b. **Transmission device**—This is usually a waveguide which acts as a chute through which the microwaves are directed into the oven cavity
- c. **Distribution device**—This is usually a fan-like device called a stirrer which spreads the microwaves in a random pattern to assure even distribution of the microwaves into the oven cavity
- d. **Oven cavity**—A resonant chamber into which food is placed for thawing, heating, or cooking
- e. **Interlock system**—Primary and secondary safety devices on a microwave oven door to assure that microwave transmission will stop immediately when the door is opened

7. Magnetron structure and operation

- a. Most magnetrons are constructed as a series of cylinders:
 - (1) The outer cylinder is a permanent magnet.
 - (2) The middle cylinder is an anode with vanes or ridges in it that create "resonant cavities".
 - (3) The inner cylinder is a cathode with a heating filament in the center.
- b. As high voltage is supplied to the magnetron from a transformer, the filament heats the cathode.
- c. As the cathode is heated, it gives off electrons whose negative charges are attracted to the anode which operates at a positive potential.
- d. The magnetic field around the anode repels the electrons so that they travel in a circular path to reach the anode instead of traveling in a straight line as electrons normally would.

- e. As the electrons move in a rapid orbit from cathode to anode, they travel past the resonant cavities in the anode and cause the cavities to vibrate a high frequency.
- f. The pulsating 2450 MHz frequency generated by the magnetron is picked up by the antenna and directed into a waveguide and on to a stirrer which distributes the microwaves into the oven cavity.

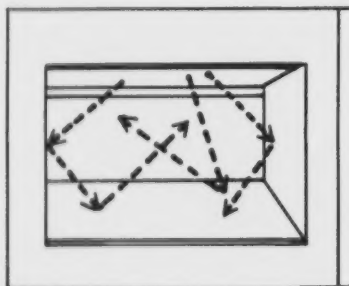


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8. The significance of microwave reflection

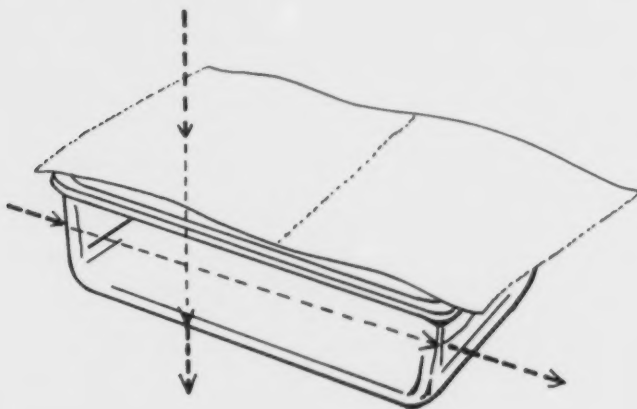
- a. The walls inside a microwave oven never get hot because metal reflects microwaves, and for that same reason, a microwave oven should never be operated without a load.
- b. Metal utensils cannot be used in a microwave because they cause arcing that can damage components.
- c. Aluminum foil can be used in limited quantity to shield parts of food to assure even cooking.

Example: When cooking a turkey, putting foil over the legs will shield them from overcooking.



9. The significance of microwave transmission

- a. Since microwaves easily penetrate glass, paper, and plastic, most utensils made from these materials are safe for use in a microwave oven.
- b. Glass utensils are best for foods high in fat or sugar content because such foods can distort certain plastics.
- c. Paper towels can be used beneath foods to help keep the oven clean or placed over bacon to avoid splatter.

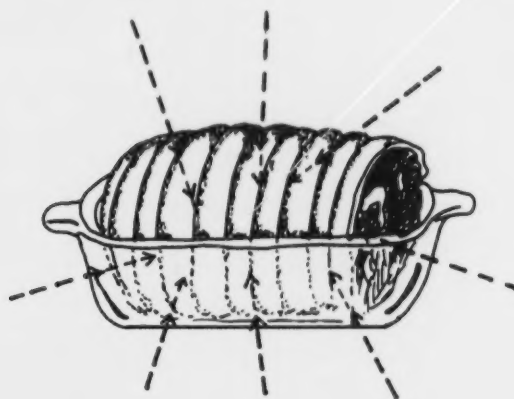
**10. The significance of microwave absorption**

- a. The fact that foods absorb microwaves is the key to microwave cooking.
- b. The process of absorption is also used to defrost frozen foods or to keep foods warm by employing a timed sequence in which the magnetron is on for awhile, then off for awhile.

Note: This variable defrost or warming control is an attractive feature of microwave ovens, but it does not mean that magnetron power is ever reduced; it is accomplished, as outlined, by controlling the on/off time of the magnetron.

- c. How fast foods absorb microwaves depends on the amount of food, temperature of the food when cooking starts, and even the shape of food.

Note: Placing food properly is one of the secrets of good microwave cooking because it avoids problems with food that can literally be partly overcooked and partly undercooked; encouraging a customer to reference a microwave cook book is a good thing to do.



11. Steps in microwave cooking

- a. As microwaves enter food, they set up electrical fields that change polarity every half cycle.
- b. Molecules in the food, especially water and fat molecules, start moving back and forth and changing directions every half cycle just as the microwaves do.
- c. Food molecules oscillate back and forth four billion, nine hundred million times every second.
- d. The ultra high-speed oscillation produces friction between the molecules which converts the microwave energy to instant heat.
- e. Microwaves penetrate food up to a depth of 2 inches and accelerate the conduction of heat, but microwaves do not cook food from the inside out.

12. Steps in properly installing a microwave oven

- a. Check the oven thoroughly to assure there is no damage.
- b. Remove all material from the oven interior.
- c. Place the oven in location and check for:
 - (1) one inch of clearance at the top and back,
 - (2) two to three inches clearance on each side, and
 - (3) sufficient clearance to assure air flow at the bottom of the oven.

Caution: Clearances should never be less than specified by the manufacturer.

- d. Plug oven into a 120 volt three-prong or four-prong grounded outlet only.
- e. Check for at least a 15 amp circuit and make sure the microwave is the only appliance on that circuit.

Note: It is the customer's responsibility to contact an electrician, if required, to assure a proper circuit for a microwave oven; otherwise, there may be oven problems or problems with other appliances or services on the circuit.

- f. If oven has been stored in a cold location, let it warm to room temperature before operating.
- g. Place a cup of water in the oven cavity and close the door.
- h. Push the start button to put the oven in a COOK cycle for 30 seconds.
- i. Open oven door, remove water, and check water to make sure it has been heated to show oven is ready for operation.

13. General rules for preventive maintenance

- a. Clean the stirrer cover and the oven with a damp cloth after each use.
- b. Wipe out excess moisture after every use.
- c. Use a plastic scrub pad with a mild detergent to clean up stubborn soils, but do not use steel wool or abrasive pads or cleaners that could scratch the door and interior surface.

Information Sheet

- d. Use a damp cloth to clean a temperature probe after each use, and dry the probe after cleaning, but do not put the probe into dishwater or a dishwasher.
- e. Do not use a knife to scrape the stirrer cover clean because it could easily damage the cover and affect oven performance.
- f. Remember that caked-on food buildup on oven or door surfaces affects oven performance.
- g. A clean oven looks better, smells better, and cooks better.
- h. Inspect air intakes and outlets weekly to make sure someone has not blocked them.

14. Major microwave oven components and their functions

- a. **Power transformer**—A transformer that converts 120V AC current into low voltage (about 3.2V AC) that is fed to the magnetron filaments, and into high voltage (about 1900V AC) that is fed into the voltage-doubler circuit
- b. **Voltage-doubler circuit**—A diode/rectifier/capacitor combination that converts the high voltage AC feed from the transformer into approximately 3900V pulsating DC current that is fed into the magnetron
- c. **Magnetron**—A cylinder-shaped cathode/anode in a magnetic field that converts applied low voltage AC and high voltage DC current into microwaves
- d. **Antenna**—The part of the magnetron tube that directs generated microwaves into a waveguide
- e. **Waveguide**—A duct-like channel through which the microwaves travel in controlled transmission to the stirrer assembly
- f. **Stirrer assembly**—A device with fan-like blades that scatter the microwaves at random into the oven cavity to assure even heat distribution in the cavity

15. Requirements for RF leakage test instruments

- a. Leakage test instruments must always be set at a frequency at 2450 MHz.
- b. Leakage test instruments must have a response time that permits them to reach 90% of their response capacity in only three seconds.

Note: This requirement assures that the test can be almost instantly discontinued if there is immediate evidence of RF leakage, and provides added protection for service people.

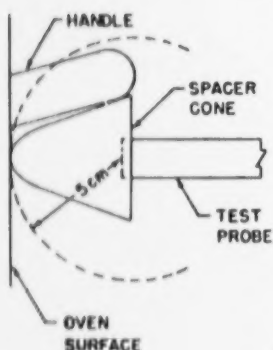
Information Sheet

- c. Batteries in test instruments should be checked prior to every use and replaced as required.
- d. Spacer cones and probes should be checked prior to each use to assure they are clean and undamaged.

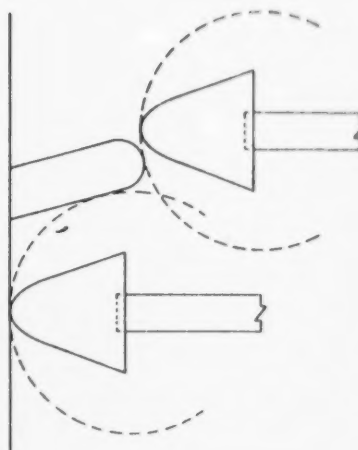
16. Requirements for spacer cones

- a. Spacer cones are fitted over detector probes to assure that the center of the probe is kept 5 cm, about 2", from external surfaces such as latches and control knobs.
- b. The spacer cone can also be used to assure that the detector is held at a 90° angle to the oven surface or area being tested.

Incorrect

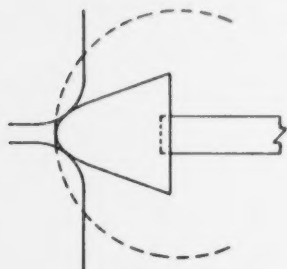


Correct

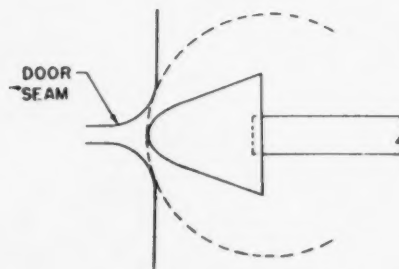


- c. When testing door seams on an oven, do not force the spacer cone into the discontinuity between the door; keep the spacer cone at a proper angle and retain the 5cm of 2" test distance.

Incorrect



Correct



17. **Operating controls and their functions (Student Supplement 1)**

- a. **Interlock switches**—These switches are activated by the opening or closing of the oven door to assure that microwave generation does not start until the door is properly closed and stops the moment the door is opened
- b. **Interlock monitor**—A device that instantly shuts off microwave transmission in the event any interlock switch fails
- c. **Timer**—May be a rotary, digital, pushbutton, or touchpad device, and is designed to stop microwave generation at the end of a specified period.
- d. **Start/stop controls**—Permits selection of COOK, DEFROST or other conditions of a particular oven, and some oven doors cannot be opened until STOP has been pressed
- e. **Thermal protectors**—Devices which stop oven operations in the event a blower obstruction causes a magnetron to overheat or the oven cavity to overheat
- f. **Cook relay**—Activated by depressing the COOK switch to generate a current path to the stirrer assembly, transformer, and cook light
- g. **Controller**—Used on microwave ovens to start and stop microwave transmission for thawing food or keeping food warm during a variable heat cycle

Note: Keeping food warm or thawing food is not accomplished by reducing the power output of the magnetron; the warm or thaw mode simply means the magnetron turns on and shuts off at intervals determined by the controller.

- h. **Triac**—A switching relay used for controlling circuits in a microwave oven

18. **Motors in microwave ovens (Student Supplement 1)**

- a. **Blower motor**—A motor that drives a fan which directs air around the vanes of the magnetron to help keep it cool and also directs some air through the oven cavity to remove steam and vapors from cooking food
- b. **Stirrer motor**—A motor that drives a fan which deflects microwaves from the waveguide into the oven cavity
- c. **Turntable motor**—A motor that drives the revolving tray in some microwave ovens

Note: Some ovens equipped with turntables use a stepdown winding on the blower motor to turn the tray.

19. Door seals and their importance

- a. Door seals must be so designed that they prevent the escape of microwaves from the oven.
- b. Door seals must be so designed that they can limit RF leakage from the oven door to a maximum level of 5mw/cm^2 .
- c. A "capacitive seal" is a flexible metal plate with a thin insulated coating to break metal-to-metal contact and prevent arcing when the oven door is closed.

Note: Capacitive seals are so called because they create a very low resistance path, like a capacitor, between the oven door and the cavity.

- d. A "choke seal" is so structured that the dimensions are related to the wavelength of microwaves, and will actually reflect stray microwaves back into the oven cavity.
- e. "Absorbent seals" are made of plastic or synthetic rubber and may have a ferritic content to help them absorb harmonic energy that might get by the other seals.
- f. Door seals are critical to safe microwave oven operation and should be carefully inspected anytime an oven is first delivered or later serviced.

20. Technical materials required for microwave oven service

- a. The nameplate on the oven should always be checked for the proper model number and serial number.
- b. The service manual for the specific oven being worked on must be available to assure proper references for circuitry and parts.
- c. Service bulletins, technical updates, or literature that lists engineering changes that affect component or parts modifications for the oven must be available.
- d. Replacement parts should be ordered by number from the parts catalog for the specific oven being serviced.
- e. Circuit diagnosis and troubleshooting should not begin without a proper wiring schematic for the specific oven being serviced.

Note: Schematics are usually included in service manuals and revised schematics sometimes appear in service bulletins, but be sure to read legends that appear with schematics or wiring diagrams.

Information Sheet**21. Steps in troubleshooting a microwave oven**

- a. Complete pre-service inspection and make sure you have the model and serial number for reference.
- b. Check troubleshooting procedures in service manual.
- c. Make sure your technical materials reflect engineering changes and are otherwise up to date.
- d. Start with a proper wiring schematic and a circuit diagnosis.

Note: The wiring schematic in Student Supplement 2 is the conditional schematic for Litton microwave ovens, model 1304, 1305, 1420, and 1422, and should be referenced as required for the job sheets included in this unit.

- e. Perform components tests in order.
- f. Use a parts catalog that specifically lists parts and components for the oven being repaired.
- g. Make an RF leakage test after repairs are complete, and leave a leakage test tag on the oven.
- h. Run the oven through a complete operating cycle to insure everything is in order.

22. Pre-service inspection requirements for microwave ovens

- a. Check interlock operations and proper door closing.
- b. Examine the seals and door surfaces for signs of arcing, wear, or damage that could endanger the integrity of the door.
- c. Check the door hinges to make sure they are not loose or damaged.
- d. Examine the oven wrap and all exterior surfaces for evidence of misuse or abusive use such as dropping.
- e. Check the magnetron and waveguide for proper alignment.
- f. Check the stirrer assembly.
- g. If there is evidence of abuse or doubts about the microwave generating components, the oven should not be serviced.

23. Safety requirements for microwave oven service

- a. Always inspect the oven before starting any tests or service.
- b. Unplug the power cord to the oven before removing access panels or oven wraps.
- c. DISCHARGE THE CAPACITOR by shorting across the capacitor terminals with a screwdriver that has an insulated handle.

Caution: If a capacitor is at full charge, it can be damaged by shorting across the terminals; the best way to discharge a full or partially charged capacitor is to bleed the charge through a 20K Ω resistor, that procedure is outlined in Job Sheet 1.

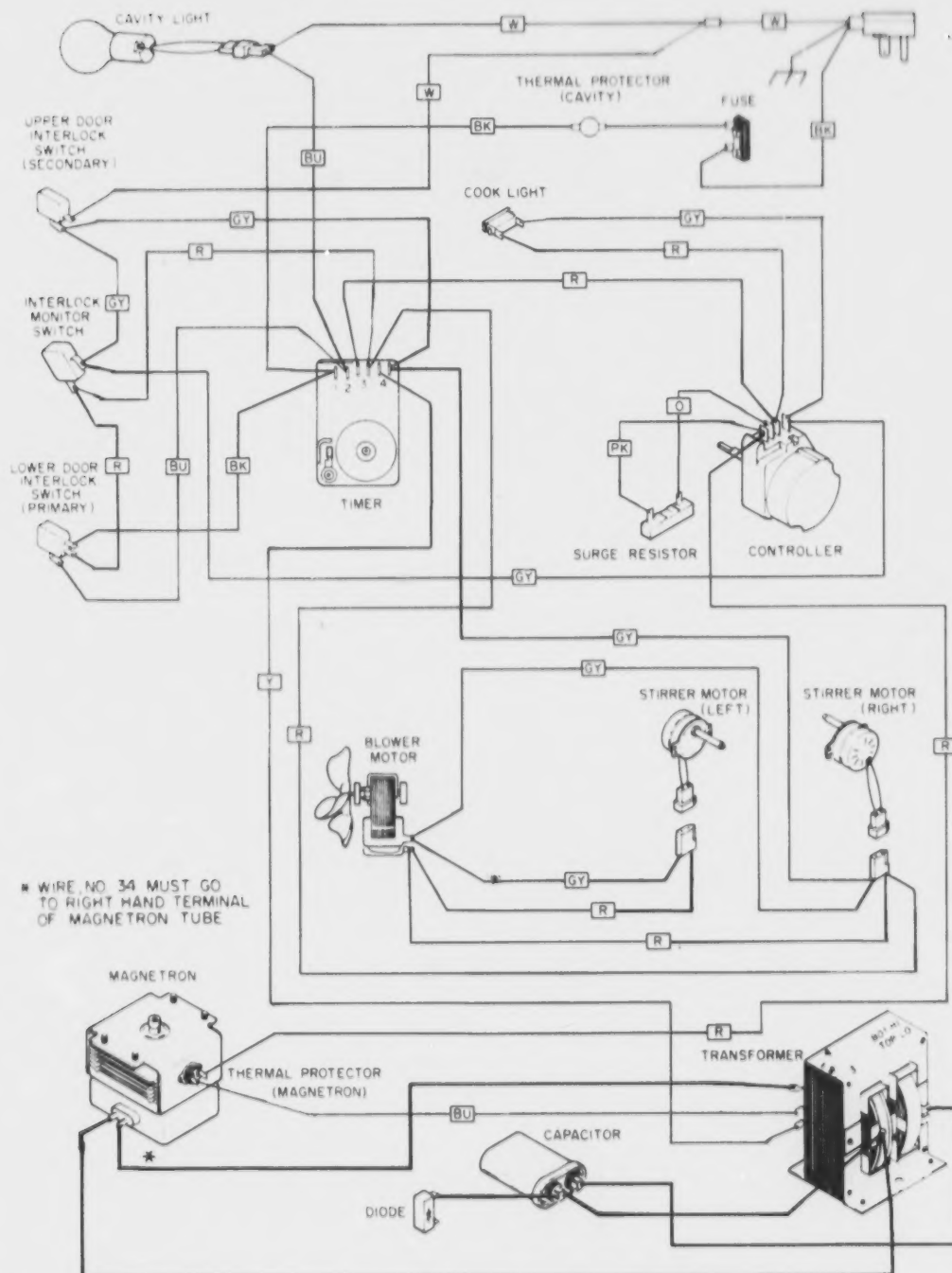
- d. When a test routine calls for operating the oven for a "live" test, make all test connections BEFORE YOU PLUG THE UNIT INTO THE POWER RECEPTACLE.
- e. Use alligator clips when making "live" tests so you will not have to hold VOM leads near areas of dangerous high voltages.
- f. Operate the unit only from a three-prong or four-prong grounded outlet on a 15-amp circuit that services the microwave only.
- g. When using an extension cord for testing, use a three-wire grounded cord of at least 16-gauge copper, but do not use a two-wire extension cord.
- h. NEVER take high voltage readings around the transformer or the magnetron.
- i. Rings, bracelets, watches and watch bands, metallic neck chains, and metal jewelry of any kind could accidentally touch a nearby component and cause severe injury for a technician servicing microwave components; **always remove jewelry before accessing and testing operating components of a microwave!**

24. Post-service safety requirements for microwave ovens

- a. Attach a note to the oven to indicate what the customer can do to avoid further problems if the problem resulted from any form of misuse or lack of proper maintenance.
- b. Conduct an RF leakage test to assure that oven microwave emissions are at or below the 5mw/cm² maximum level set by the Department of Health and Human Services.
- c. Fill out a leakage test tag listing the type of leakage test instrument used, the serial and model numbers of the oven, the date the test was made, and the signature of the technician that made the test.

Microwave Ovens Unit 14

Student Supplement 1—Microwave Oven Components



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794

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Microwave Ovens
Unit 14

MAR-531

Student Supplement 2—Circuit Diagnosis

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A. To use a schematic for troubleshooting you need to know:

1. what the oven set-up schematic shows,

Example: Is the oven OFF with the door OPEN, or is the oven in a COOK cycle or at some other setting?

2. what the normal condition of the oven should be, and

Example: With the timer set to OFF, and the door OPEN (set up), the cavity light be ON (normal condition).

3. the problem.

Example: The cavity light does not light.

B. Begin troubleshooting at the circuit breaker and proceed through the circuitry identifying the components or conditions that could be causing the problem(s).

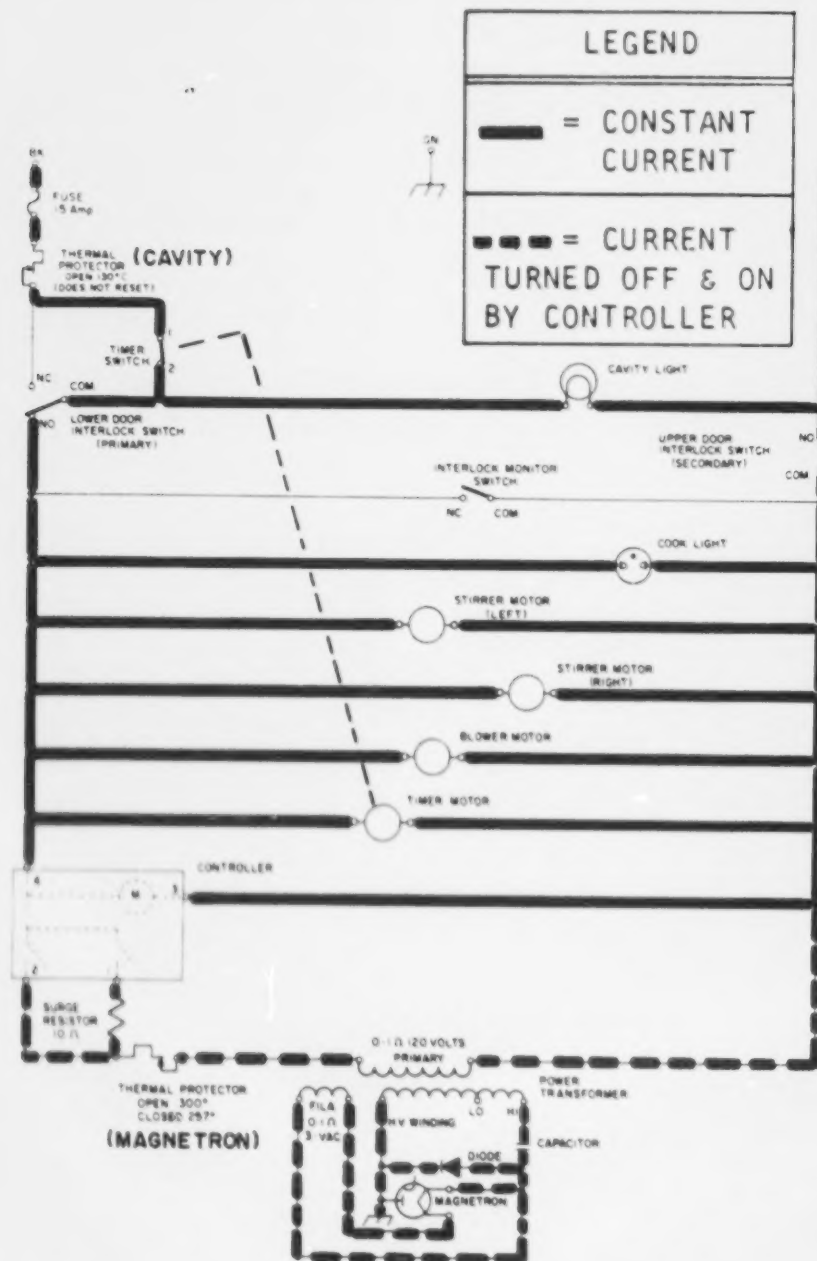
Example: In A3, the possible causes of the cavity light not lighting could be any one or combination of things:

1. it could be a blown wall fuse or a tripped circuit breaker.
2. it could be a blown 15A fuse.
3. it could be a defective cavity terminal protector.
4. it could be a defective lower door interlock switch.
5. it could be a defective cavity light.
6. it could be a defective cavity light socket.
7. it could be a loose or broken connection.

C. Make all component tests in order to assure effective systematic troubleshooting.

Student Supplement 2

Microwave Oven in VARI-COOK Condition

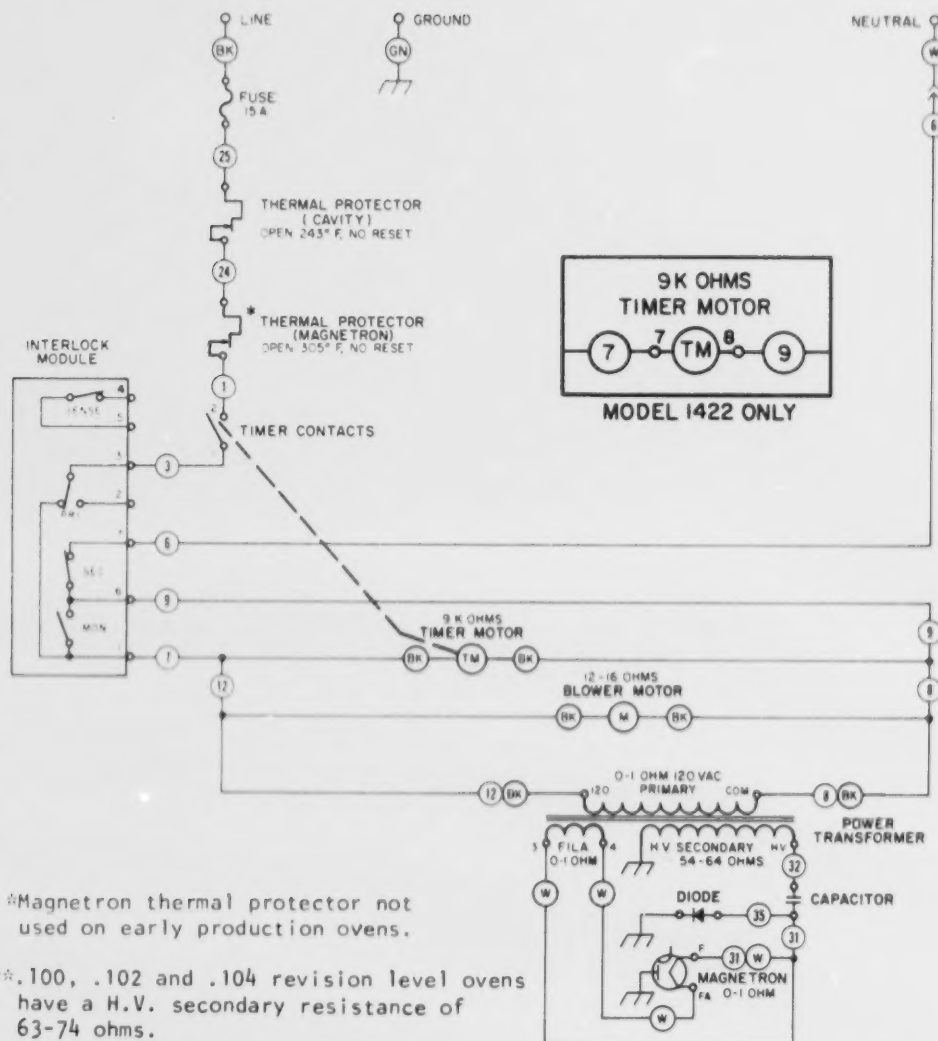


796

Microwave Oven in IDLE Condition

CONDITION OF OVEN
DOOR CLOSED
TIMER OFF

WARNING: DISCONNECT ELECTRICAL
POWER BEFORE SERVICING



	SWITCH FUNCTION CHART			
	INTERLOCK MODULE			TIMER
CONTACTS	PRIMARY	SECONDARY	MONITOR	
1	3	6	1	2
FUNCTION	1	2	7	6
DOOR OPEN		•		•
DOOR CLOSED	•		•	
TIMER OFF				
TIMER ON				•

WARNING: THERE IS EXTREMELY HIGH
VOLTAGE PRESENT AROUND THE POWER
SUPPLY COMPONENTS.

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Microwave Ovens
Unit 14

Student Supplement 3—Circuit Diagnosis, Oven in COOK condition

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A. Overr set-up:

1. Open oven door.
2. Place container of water in oven cavity.
3. Set vari-cook dial to setting other than HIGH.
4. Set timer dial to two minutes.
5. Close oven door.

B. Normal operation:

1. Cavity light on.
2. Cook light on.
3. Stirrer motors operate.
4. Blower motor operates.
5. Timer motor operates.
6. Controller operates.
7. Oven heats load placed in cooking cavity at selected vari-cook power level.
8. Timer shuts off oven at end of selected time setting.

Student Supplement 3

C. First problem:

1. Oven appears to operate normally, but continues to heat on HIGH (full power).
2. Possible causes:
 - a. defective electro-mechanical controller assembly.
 - b. broken or loose wire connection.
 - c. defective primary (lower door) interlock switch.
 - d. defective secondary (upper door) interlock switch.
 - e. broken or loose wire connection.

D. Third problem:

1. Timer does not advance, but other operations normal.
2. Possible causes:
 - a. defective timer assembly.
 - b. binding timer assembly.
 - c. broken or loose wire connection.

E. Fourth problem:

1. Cook indicator light does not illuminate, but other operations are normal.
2. Possible causes:
 - a. defective cook indicator light.
 - b. broken or loose wire connection.

G. Fifth problem:

1. Stirrer blade does not rotate, but other operations are normal.
2. Possible causes:
 - a. defective stirrer motor.
 - b. stirrer blade binding.
 - c. broken or loose wire connection.

Student Supplement 3

H. Sixth problem:

1. Blower motor does not operate, but other operation normal.
2. Possible causes:
 - a. defective blower motor.
 - b. blower fan binding.
 - c. broken or loose wire connection.

I. Seventh problem:

1. Cavity light stays on at the end of cook cycle.
2. Possible cause: defective primary (lower door) interlock switch.

J. Eighth problem:

1. Oven appears to operate normally, but heats very slowly.
2. Possible causes:
 - a. vari-cook control not set to appropriate power level.
 - b. low line voltage.

Note: Line voltage should be 120V, and during operation, line voltage should never drop below 105V.

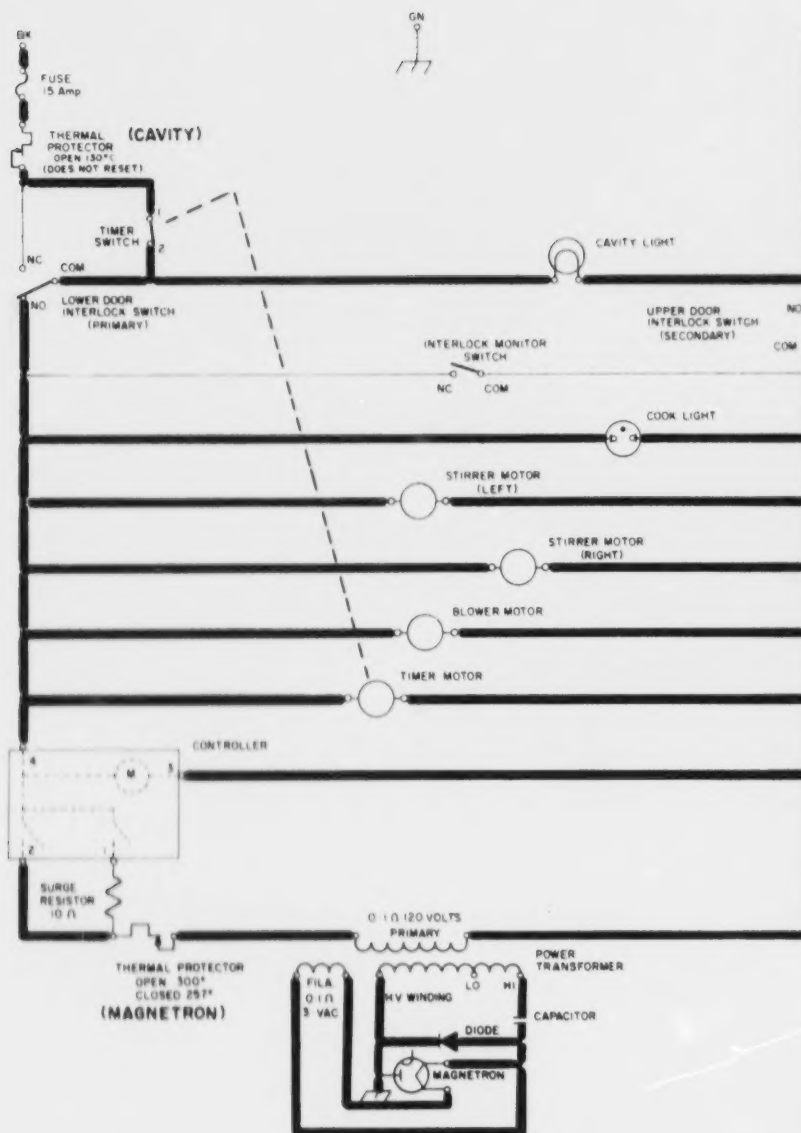
- c. defective electro-mechanical controller.
- d. overheat condition causing thermal protector to open.
- e. defective magnetron.
- f. defective capacitor.
- g. defective power transformer.

Student Supplement 3**K. Ninth problem:**

1. Oven appears to operate normally, but does not heat at all.
2. Possible causes:
 - a. defective electro-mechanical controller.
 - b. defective magnetron thermal protector.
 - c. defective diode.
 - d. defective capacitor.
 - e. defective transformer.
 - f. defective magnetron.
 - g. broken or loose wire connection.

Student Supplement 3

Microwave Oven in COOK Condition



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Microwave Ovens
Unit 14

MAR-541

Student Supplement 4—Circuit Diagnosis, Oven in VARI-COOK condition

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A. Oven set-up:

1. Open oven door.
2. Place container of water in oven cavity.
3. Set vari-cook dial to HIGH.
4. Set timer dial to two minutes.
5. Close oven door.

B. Normal operation:

1. Cavity light on.
2. Cook light on.
3. Stirrer motors operate.
4. Blower motor operates.
5. Timer motor operates.
6. Oven heats load placed in cavity.
7. Timer shuts off oven at end of selected time setting.

C. First problem:

1. Cavity light illuminates with door open, but when door is closed, cavity light goes off *and* no components operate.
2. Possible cause:
 - a. defective timer switch.
 - b. broken or loose wire connection.

Student Supplement 4

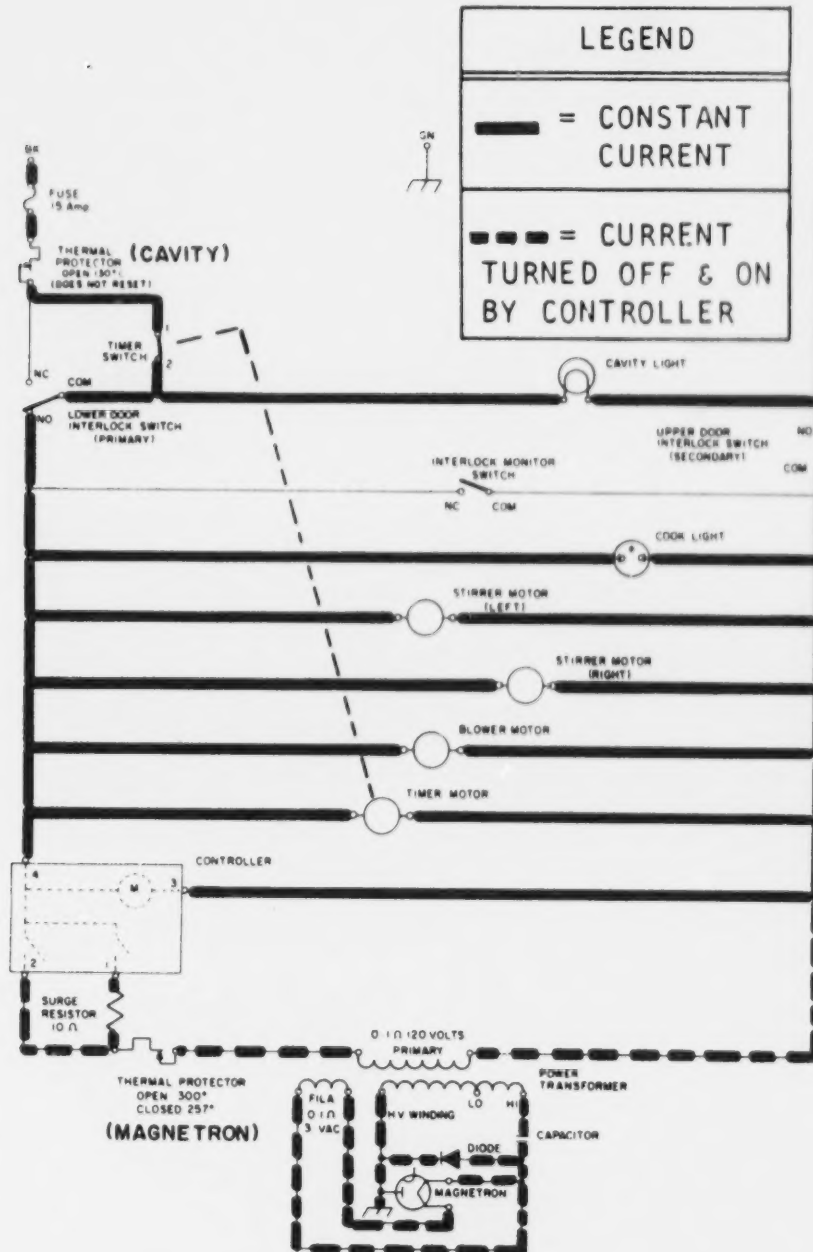
D. Second problem:

1. Cavity light illuminates, but timer *and* other components do not operate.
2. Oven appears to operate normally, but does not heat at all.
3. Possible causes:
 - a. defective electro-mechanical controller assembly.
 - b. broken or loose wire connection.

E. Special conditions for the VARI-COOK diagnosis:

1. Test the COOK CONDITION first to make sure it is operating normally.
2. Knowing why the controller works as it does will help you better understand its functions and the functions of the surge resistor:
 - a. During vari-cook operation, the controller motor alternately opens and closes the controller contacts 4, 1, and 2, and the "ON" time is dependent upon the vari-cook dial setting.
 - b. When contact 4 and 1 closes, power is applied through the surge resistor to the primary of the power transformer.
 - c. A moment later, contact 4 and 2 closes, bypassing the surge resistor.
 - d. The contact closure sequence limits start-up current surges to protect the controller contacts.

Microwave Oven in VARI-COOK Condition



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**Microwave Ovens
Unit 14****Assignment Sheet 1—Diagnose Circuit Problems When an Oven is in a
Cavity-Light ON Condition**

Name _____ Overall Rating _____

Evaluation Criteria	Rating
Number of causes listed for no light problem	_____
Number of correct listed causes	_____

Directions: Refer to Student Supplement 2 for a schematic. Assume that set-up includes the timer set in the OFF position and the oven door open. The cavity light should come ON.

Problem: The cavity light does not come on. What are at least four causes of the problem:

- a. _____

- b. _____

- c. _____

- d. _____

Microwave Ovens
Unit 14

MAR-547

Assignment Sheet 2—Diagnose Circuit Problems When an Oven
is in the COOK condition

Name _____ Overall Rating _____

Evaluation Criteria	Rating
Number of problems answered	_____
Number of correct answers	_____

Directions: Refer to Student Supplement 3 for a schematic and assume the following set-up: You open the oven door, place a container of water in the oven cavity, set the vari-cook dial to HIGH, set the timer for two minutes, and then close the oven door.

Look for a normal operation which should include: the cavity light ON, the cook light ON, stirrer motor is operating, blower motor is operating, timer motor is operating, oven heats the water placed in the cavity, and the timer shuts the oven OFF at the end of the selected time setting.

Problem 1: The cavity light illuminates with door open, but when door is closed, cavity light goes off *and* no components operate. What are two possible causes?

a. _____

b. _____

Problem 2: Cavity light illuminates, but timer *and* other components do not operate. What are two possible causes?

a. _____

b. _____

Problem 3: Timer does not advance, but other operations normal. What are two possible causes?

a. _____

b. _____

Assignment Sheet 2

Problem 4: Cook indicator light does not illuminate, but other operation normal. What are two possible causes?

a. _____

b. _____

Problem 5: Stirrer blade does not rotate at one side (left or right) of oven cavity, but other operation normal. What are two possible causes?

a. _____

b. _____

Problem 6: Blower motor does not operate, but other operation normal. What are two possible causes?

a. _____

b. _____

Problem 7: Cavity light stays on at end of cook cycle. What is the most obvious cause?

Problem 8: Oven appears to operate normally, but heats very slowly. What are five possible causes?

a. _____

b. _____

c. _____

d. _____

e. _____

Problem 9: Oven appears to operate normally, but does not heat at all. What are five possible causes?

a. _____

b. _____

c. _____

d. _____

e. _____

**Microwave Ovens
Unit 14****Assignment Sheet 3—Diagnose Circuit Problems When an Oven
is in the VARI-COOK Condition**

Name _____ Overall Rating _____

Evaluation Criteria	Rating
Number of problems answered	_____
Number of correct answers	_____

Directions: Refer to Student Supplement 4 for a schematic and assume the following set-up: You open the oven door, place a container of water in the oven cavity, set the vari-cook dial to HIGH, set the timer for two minutes, and then close the oven door.

Look for a normal operation which should include: the cavity light ON, the cook light ON, stirrer motor is operating, blower motor is operating, timer motor is operating, controller is operating, oven heats the water at the VARI-COOK power level, and the timer shuts the oven OFF at the end of the selected two-minute time setting.

Problem 1: The oven appears to operate normally, but continues to heat on HIGH (full power) or does not heat at all. Assuming there is no broken wire or faulty connection, what are the most obvious causes of the problem?

Answer _____

**Microwave Ovens
Unit 14****Job Sheet 1—Test the Interlock System on a Microwave Oven
For Safe Operation**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Preliminary information properly noted and recorded	_____
Components and door checked	_____
Interlock system tested and verified safe	_____

A. Tools and materials

Microwave oven as selected by instructor
Operating manual for selected oven
16-oz measuring beaker and cool water supply
Paper and pencil
Safety glasses

B. Routine 1—Gather preliminary information

- ☐ 1. Put on safety glasses.
- ☐ 2. Unplug the microwave oven from its power source.
- ☐ 3. Position the oven so that the metal tag on the rear panel can easily be read.
- ☐ 4. Complete the following information concerning the oven specifications:

a. Manufacturer's Name: _____

b. Serial Number: _____

c. Model Number: _____

d. Operating Frequency: _____

Note: If the operating frequency is not listed, it should be in the operating manual, and if it is not in the manual, it will have to be obtained by contacting the manufacturer.

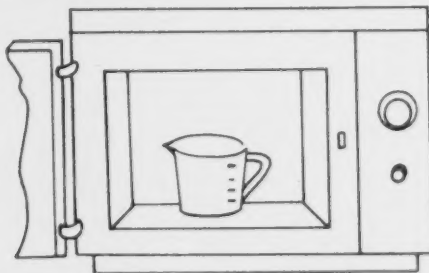
Job Sheet 1

- ☐ 5. Check as best you can the major electronic components located between the cabinet and the cavity walls:
- a. Is the cavity free of odors that would indicate a component may have burned? _____
 - b. Does the magnetron appear to be okay? _____
 - c. Does the waveguide appear to be okay? _____
 - d. Do the stirrer and stirrer blades appear to be okay? _____
- ☐ 6. Check the door, door gasket, and oven surfaces:
- a. Are the door seals in place? _____
 - b. Are the door seals free of cracks or separations? _____
 - c. Is the glass in the door free of cracks or other visible damage? _____
 - d. Are outside oven surfaces free of dents or scratches that would indicate the oven has been dropped or abused? _____
 - e. Are door hinges free of sag and excessive play? _____
- ☐ 7. Have your instructor check your work.

Note: If you answered NO to any of the preliminary inspection questions, your instructor may request you to stop your inspection at this point and complete needed repairs before starting the next routine.

C. Routine 2—Check the interlock system

- ☐ 1. Fill the measuring beaker with nine ounces of cool water and place the beaker in the center of the oven cavity.



- ☐ 2. Close the oven door and plug the power cord in.
- ☐ 3. Set the power control at the highest available level.

Job Sheet 1

- ☐ 4. Set the timer for three to five minutes.
- ☐ 5. Press the start button.
- ☐ 6. Permit the water to come to a boil and quickly open the oven door just a bit less than one inch:
 - a. If the interlock system is functioning properly, the water will stop boiling as soon as the door latch is released.
 - b. If the interlock system is not functioning properly, the water will continue to boil as the door latch is released.
 - c. If the water does continue to boil, close the oven door quickly and unplug the power supply to the oven.
- ☐ 7. Have your instructor check your work.
- ☐ 8. Continue with a formal leak test as directed or clean up area and return tools and materials to proper storage.

Comments _____

**Microwave Ovens
Unit 14****Job Sheet 2—Check an RF Leakage Test Meter and Test a Microwave Oven
For RF Leakage**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Meter battery tested, warmed up and zeroed	_____
Oven prepared with load for proper testing	_____
Readings taken at strategic interfaces as directed	_____
All readings recorded on RF Leakage Chart	_____
Testing conducted with proper attention to safe procedures	_____

A. Tools and materials

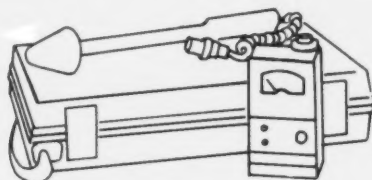
RF Leakage detection meter (NARDA model 8200 or equivalent)
Detection probe w/spacer cone
Nine-volt battery
Operator's manual for meter and probe
Selected microwave oven
Sixteen-ounce measuring beaker
Pencil and paper
Safety glasses

B. Routine 1—Check an RF leakage test meter

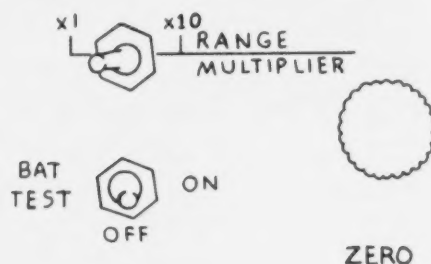
- ☐ 1. Put on safety glasses.
- ☐ 2. Remove the meter and components from the carrying case.
- ☐ 3. Read the operator's manual to make sure the meter is made for 2450 MHz and a maximum operating power density of 20 mW/cm².

Job Sheet 2

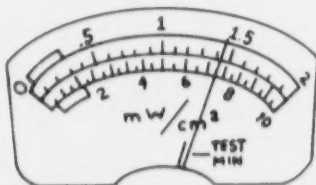
- ☐ 4. Check the equipment to be sure it includes the radiation meter along with a detachable detection probe, a spacer cone, and a 9-volt battery.



- ☐ 5. Check the operator's manual, if required, to make sure that the meter is made for a frequency of 2450 MHz and that its maximum operating power density is 20 mW/cm.
- ☐ 6. Set the meter on a clean work area where it can be clearly seen.
- ☐ 7. Turn the range multiplier switch to the X1 setting.

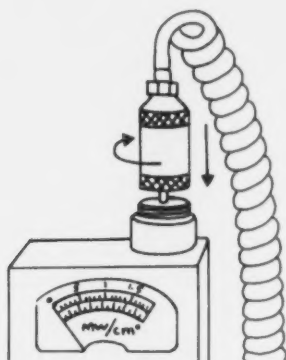


- ☐ 8. Turn the BAT TEST (battery test) switch to the BAT TEST position.
- ☐ 9. Look for the TEST MIN (test minimum) mark at the bottom of the meter scales and make sure the needle settles to the right of the TEST MIN mark:
- If the battery test needle settles anywhere to the left of the TEST MIN mark, turn the switch to the OFF position, check the operator's manual for the procedure, and replace the battery.
 - Check the replacement battery with the procedure outlined in Steps 8 and 9.

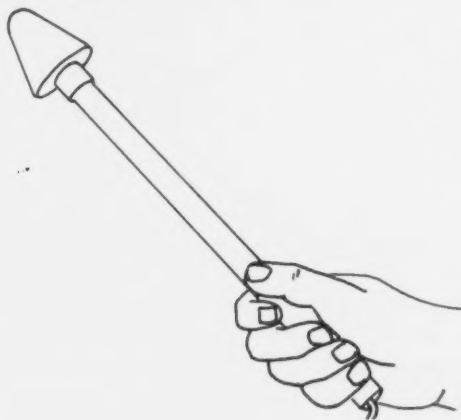


Job Sheet 2

- ☐ 10. Attach the probe to the meter by grasping the connector at the end of the coiled probe cord and pushing it into the fitting on top of the meter.
- ☐ 11. Turn the connector onto the fitting clockwise until it is hand tight.

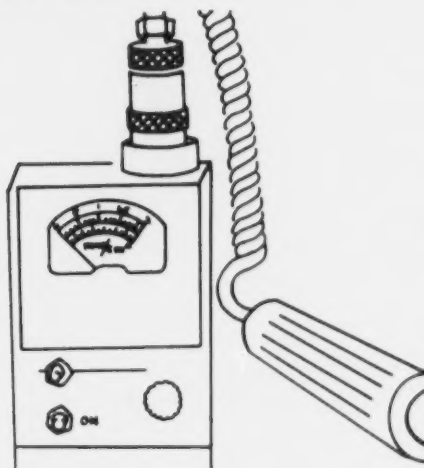


- ☐ 12. Examine the spacer cone to make sure it is not damaged, and then place it on the free end of the probe.



Job Sheet 2

- ☐ 13. Check the operator's manual for warmup requirements, and turn the meter on and wait until warmup time is over.
- ☐ 14. Turn the zero adjust knob as required to align the indicator needle with the zero line to the left of the scales.



- ☐ 15. Have your instructor check your work.
 - ☐ 16. Turn the unit off and return it to proper storage or continue with leak testing as directed by your instructor.
- C. Routine 2—Test a microwave oven for leakage
- ☐ 1. Put on safety glasses.
 - ☐ 2. Fill a beaker with 9 ounces of room temperature water.
 - ☐ 3. Place the load (the water) into the oven cavity and close the oven door.
 - ☐ 4. Prepare your RF meter as outlined in a previous job sheet.
 - ☐ 5. Turn the range selector switch on the RF meter to the correct position.

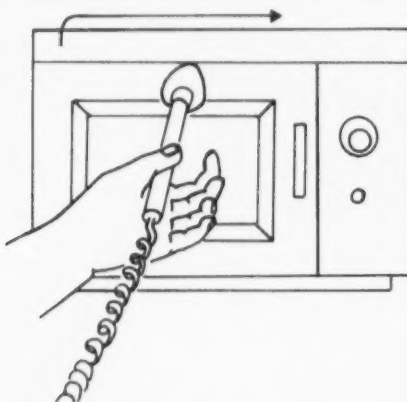
Note: On a Narda 8200, the meter should be set at the X10 position for this and following routines.

Job Sheet 2

- ☐ 6. Turn the microwave oven ON.
- ☐ 7. Pick up the meter in one hand and the test probe with the spacer cone in the other.
- ☐ 8. Start at the upper left-hand corner of the door seal with the tip of the spacer cone slightly touching the door edge.

Caution: Should any reading reach 100 mW/cm^2 quickly, turn the oven off immediately and check with your instructor!

- ☐ 9. Move the tip of the probe slowly across the top edge of the door until you reach a point where you get a reading.



- ☐ 10. Stop at any point where you get a reading and turn the shaft of the probe to obtain the highest reading possible.
- ☐ 11. Continue slowly left to right across the top edge, down the right edge, right to left across the bottom edge, and up the left edge until all edges have been completely checked.

Note: Monitor the beaker every now and then to make sure it has plenty of water in it, and if it needs refilling, turn the oven off, refill the beaker, and start again where you left off.

- ☐ 12. Record your readings as you go and enter them in the appropriate place in the chart at the end of the job sheet.
- ☐ 13. Turn the range multiplier switch to position X1 if you cannot get readings from the X10 position.
- ☐ 14. Repeat the door edge measurements at the X1 position and enter your readings in the appropriate chart.

Job Sheet 2

- ☐ 15. Hold the tip of the probe to the upper top edge of the door glass.
- ☐ 16. Move the probe slowly back and forth on the oven window until you reach the bottom of the door.
- ☐ 17. Stop at any point where you get a reading and turn the shaft of the probe to obtain the highest reading possible.

Note: Unless there is reason to suspect the glass is loose, this reading should be made at the X1 position when using the Narda 8200 meter.

- ☐ 18. Record your readings in the chart at the end of this job sheet.
- ☐ 19. Set the multiplier range at X10 and check the power cord at the point where it enters the oven cabinet.

Caution: Should any reading reach 10 mW/cm^2 quickly, turn the oven off immediately and check with your instructor!

- ☐ 20. Check all vents, air ducts, or any other openings in the oven cabinet at the X10 range, and if you do not get a reading, switch to the X1 range.
- ☐ 21. Record all readings in the appropriate chart that accompanies this job sheet.
- ☐ 22. Turn the RF meter OFF.
- ☐ 23. Turn the microwave oven OFF and unplug the power cord to the oven.
- ☐ 24. Have your instructor check RF Leakage Chart.
- ☐ 25. Remove the spacer cone from the probe and the probe from the meter and replace everything in the meter carrying case.
- ☐ 26. Return the RF meter to proper storage and double check the work area to make certain everything is in order.

Comments _____

Job Sheet 2

RF Leakage Chart

Door Edge Measurements:

Top Edge	Right Edge	Bottom Edge	Left Edge
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Highest Reading _____

Door Glass Measurements:

Upper _____

Middle _____

Lower _____

Left Side _____ Right Side _____

Power Cord Measurement: _____

Cabinet Opening Measurements: _____

Date of Survey _____

Technician's Signature _____

**Microwave Ovens
Unit 14****Job Sheet 3—Clean and Deodorize a Microwave Oven**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Lemon/water cleaner prepared and placed in oven	_____
Cleaner allowed to boil for six minutes	_____
Oven wiped clean and inspected	_____

A. Tools and materials

Microwave oven as selected by instructor
One-cup container, microwave safe
Tablespoon
Fresh lemon and fresh water supply
Cleaning cloth and pan
Safety glasses

B. Procedure

- ☐ 1. Put on safety glasses.

Note: On initial set-up or after on-site service, this is a good procedure to show a customer.

- ☐ 2. Place three tablespoons of lemon juice in the cup.
- ☐ 3. Fill the cup with water.
- ☐ 4. Place the lemon/water in the oven cavity and close the door.
- ☐ 5. Set the timer for six minutes.
- ☐ 6. Set the oven for HIGH cook cycle.
- ☐ 7. Press START.
- ☐ 8. Allow lemon/water to boil for six minutes.

Job Sheet 3

- ☐ 9. Permit oven to shut off.
- ☐ 10. Remove the cup of lemon/water.
- ☐ 11. Wipe the oven clean with a damp cloth.
- ☐ 12. Have your instructor check your work.
- ☐ 13. Clean up area and return tools and materials to proper storage.

Comments _____

**Microwave Ovens
Unit 14****Job Sheet 4—Determine if Selected Utensils are Microwave Safe**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Ovens properly prepared for utensil testing	_____
All utensils checked according to procedure	_____
Findings noted and reported	_____

A. Tools and materials

Microwave oven as selected by instructor
Utensils selected by instructor
One-cup container
Safety glasses

B. Procedure

- ☐ 1. Put on safety glasses.

Note: On initial set-up or after on-site service, this is a good procedure to show a customer.

- ☐ 2. Fill the cup with half a cup of water.
- ☐ 3. Place the cup in the oven and set the oven for HIGH.
- ☐ 4. Set the timer for one minute.
- ☐ 5. Place the first selected utensil in the oven beside the cup.
- ☐ 6. Close the oven door and press the START button.

Job Sheet 4

- ☐ 7. Allow oven to complete the one-minute cycle.
- ☐ 8. Determine results according to the following:
 - (a) If the water is hot and the utensil is cool, the utensil is safe for use in a microwave oven.
 - (b) If the water is only warm and the utensil is hot, the utensil is not safe for use in a microwave oven.
- ☐ 9. Report your findings to your instructor.
- ☐ 10. Repeat the procedure for other utensils as selected by your instructor, and report all findings.
- ☐ 11. Clean up area and return tools and materials to proper storage.

Comments _____

**Microwave Ovens
Unit 14****Job Sheet 5—Discharge a Capacitor**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Ovens properly prepared for capacitor testing	_____
Resistor leads properly positioned	_____
Capacitor safely discharged	_____

A. Tools and materials

Microwave oven w/service manual selected by instructor
Screwdriver with insulated handle
240 Ω resistor with jumper-type leads
Needlenose pliers with insulated handles
Safety glasses

B. Procedure

- ☐ 1. Remove all jewelry and put on safety glasses.
- ☐ 2. Unplug the oven power cord.

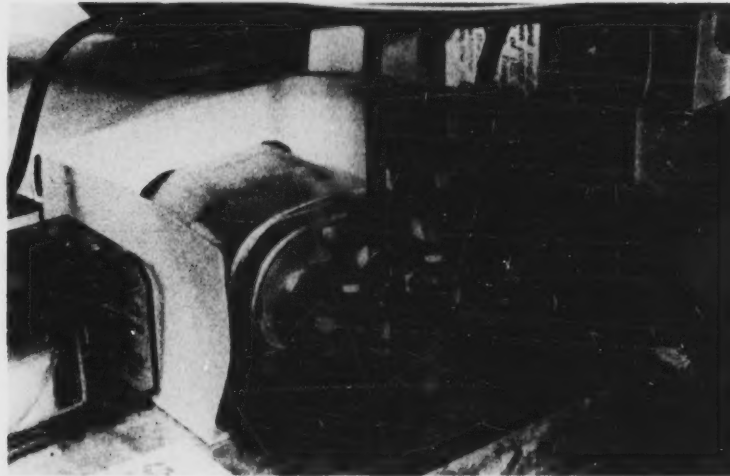
Caution: Perform the rest of this procedure only in the presence of and under the direct supervision of your instructor.

- ☐ 3. Remove the oven wrap or access panels as required to reach the capacitor.
- ☐ 4. Position the resistor leads so that they are equal to the distance between the capacitor terminals.
- ☐ 5. Hold the resistor at midpoint with a pair of pliers with insulated handles.

Note: In the next step, as you actually discharge the capacitor, be prepared to hear a light snapping noise as the capacitor discharges.

Job Sheet 5

- ☐ 6. Move the resistor and leads to a point where the leads contact the capacitor terminals, and discharge the capacitor.



- ☐ 7. Have your instructor check your work.

Note: A capacitor can be discharged by placing a screwdriver with an insulated handle across the two capacitor terminals. Your instructor may choose to show you how to do this, but do not attempt to use the procedure until you have seen it demonstrated and had an opportunity to practice it.

- ☐ 8. Clean up area and return tools and materials to proper storage.

Comments _____

**Microwave Ovens
Unit 14****Job Sheet 6—Check Stirrer Blade Rotation and Remove and
Disassemble a Stirrer System**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Stirrer system checked with visual routine	_____
Capacitor discharged with safe routine	_____
Oven prepared for removal of stirrer system	_____
Stirrer system removed and inspected for wear	_____
Stirrer system reassembled w/proper sealant used	_____

A. Tools and materials

Microwave oven, Litton model 1320, 1325, 1440, or 1450
Service manual for selected oven
Microwave-safe container and water supply
Paper and pencil
240 Ω resistor and jumper-type leads or screwdriver w/insulated handle
Standard appliance service tools
Sealant M23D2 as required
Safety glasses

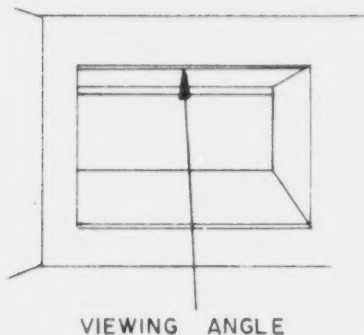
B. Routine 1—Check stirrer blade rotation

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- ☐ 1. Put on safety glasses.
- ☐ 2. Place a cup of cool water in the oven cavity and close the oven door.
- ☐ 3. Set the oven for a 20-second COOK cycle.

Job Sheet 6

- ☐ 4. After 10 seconds of operation, open the oven door, and with the oven OFF, verify stirrer rotation with the following procedure:
 - a. Position yourself below the oven so that your angle of sight permits a good view of the stirrer cover.



- b. Look for the reflections or shadows of the stirrer blade through the semi-transparent stirrer blade cover and note the position of the stirrer.
 - c. Shut the oven door and run the oven for another 10 seconds.
 - d. Open the oven door and check stirrer position again to make sure the shadow or reflection has moved to indicate the stirrer is working.
 - e. If the stirrer blade does not appear to be turning, run the test again, and if the stirrer is not working, check the stirrer as outlined in Routine 2 of this job sheet.
 - ☐ 5. Have your instructor check your work.
- C. Routine 2—Remove and disassemble a stirrer system
 - ☐ 1. Remove all jewelry and put on safety glasses.
 - ☐ 2. Discharge the capacitor as outlined in a previous job sheet.
 - ☐ 3. Leave the power cord unplugged and remove the access panel.

Job Sheet 6

- ☐ 4. Remove the stirrer cover by pulling forward to release the molded-in buttons that hold it in place.

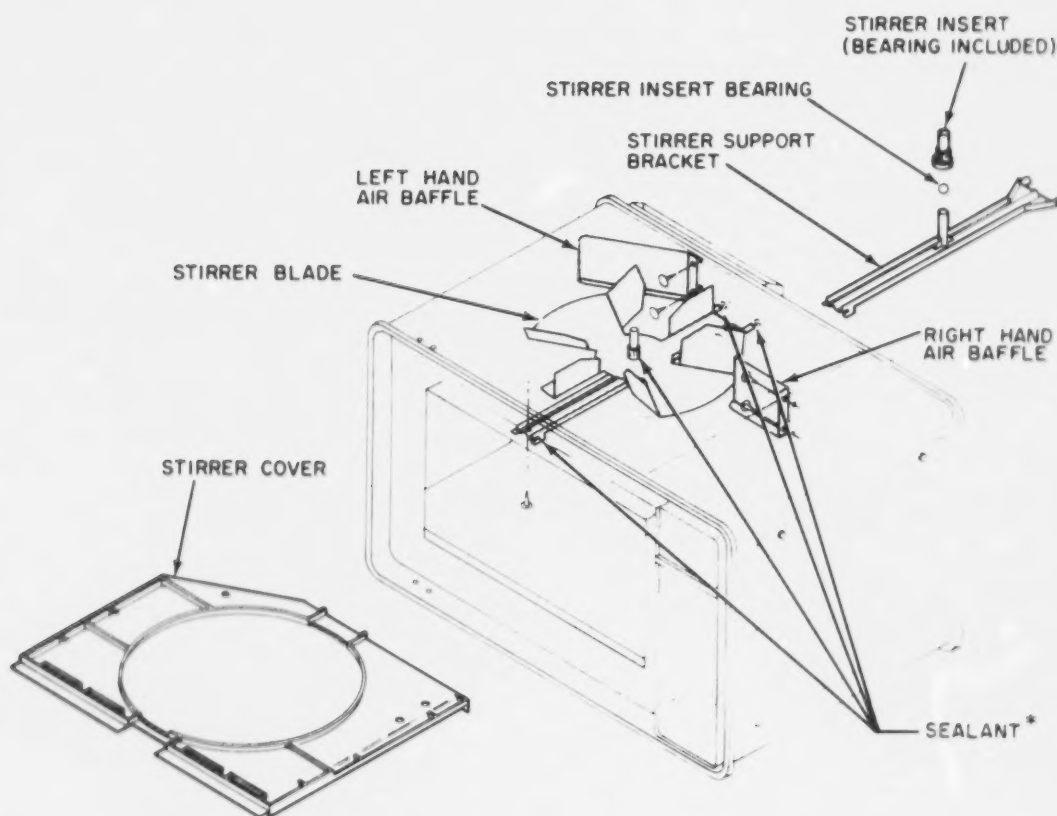
Note: The illustration for the stirrer is on a separate page of this job sheet so you can place it alongside the oven as you work.

- ☐ 5. Remove the stirrer bracket support and lower the support assembly and stirrer blade.
- ☐ 6. Remove the left and right hand air baffles as required.
- ☐ 7. Keep the stirrer insert intact with bearing and set it aside.
- ☐ 8. Inspect stirrer blade and baffles for evidence of damage.
- ☐ 9. Inspect stirrer insert and bearing for excessive wear.
- ☐ 10. Have your instructor check your work.
- ☐ 11. Reassemble the stirrer and use sealant as indicated.
- ☐ 12. Clean up area and return tools and materials to proper storage.

Comments _____

Stirrer System

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**Microwave Ovens
Unit 14****Job Sheet 7—Replace and Adjust a Microwave Oven Door Assembly**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Capacitor safely discharged	_____
New oven door installed and interlock adjusted	_____
RF leakage test conducted to verify proper installation	_____

A. Tools and materials

Microwave oven, Litton model 1304, 1305, 1420, or 1422
Service manual for microwave oven
Crows-foot type wrench
Screwdriver w/insulated handle or resistor to discharge capacitor
RF test instrument, probe and spacer cone
Replace door
Safety glasses

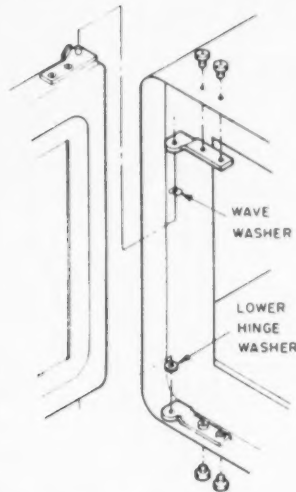
B. Procedure

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- ☐ 1. Remove all jewelry and put on safety glasses.
- ☐ 2. Unplug the power cord and remove the access panel.
- ☐ 3. Discharge the capacitor with the safe procedure outlined in a previous job sheet.
- ☐ 4. Remove the two upper hinge mounting screws from the old door.
- ☐ 5. Tilt the top of the door away from the oven and remove the oven door.

Job Sheet 7

- ☐ 6. Remove The lower hinge washer and wave washer from the old door and install them onto the new door.



- ☐ 7. Install the upper hinge onto the new door.
- ☐ 8. Install the new door into the lower hinge, leaving the door halfway open.
- ☐ 9. Install the upper hinge mounting screws, but leave the screws loose.
- ☐ 10. Close the oven door.
- ☐ 11. Place the door against the cavity faceplate near the hinges and tighten the upper hinge mounting screws.
- ☐ 12. Adjust the Interlock Switch Module as required.
- ☐ 13. Check proper door fit one more time.
- ☐ 14. Replace the access panel.
- ☐ 15. Plug in the power cord.
- ☐ 16. Have your instructor check your work.
- ☐ 17. Conduct an RF leakage test and record any problem below:

Job Sheet 7

MAR-577

- ☐ 18. Readjust door as required and test again.
- ☐ 19. Have your instructor check your work.
- ☐ 20. Clean up area and return tools and materials to proper storage; take old door to proper disposal area.

Comments: _____

Microwave Ovens
Unit 14

MAR-579

Job Sheet 8—Conduct Power Tests on a Microwave Oven to Check For
Temperature Rise Under Full Power

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Initial test water temperature properly prepared	_____
63 second test completed and results recorded	_____
Temperature rise verified and recorded	_____

A. Tools and materials

Microwave oven, Litton model 1304, 1305, 1420, or 1422
Service manual for microwave oven
Litton Power Test Kit M95D5 or equivalent plastic container
Centigrade thermometer
Pencil and paper
Stop watch or watch with second hand
Safety glasses

B. Procedure

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- ☐ 1. Put on safety glasses.
- ☐ 2. Fill the plastic container with 1,000 ml of tap water.
- ☐ 3. Place the centigrade thermometer in the water and record the initial temperature.

Note: It is important that initial water temperature be between 17°C and 27°C or 62.6°F to 80.6°F.

Initial water temp: _____

Job Sheet 8

- ☐ 4. Adjust water temperature as required by briefly heating if it is too cold or running a small amount of tap water into it if too hot.
- ☐ 5. Open the oven door and place the container on the center of the oven shelf.
- ☐ 6. Set the oven to operate at full power in the COOK condition and close the oven door.
- ☐ 7. Energize the oven and start timing simultaneously.
- ☐ 8. Heat the water for exactly 63 seconds as timed by a stop watch or second hand.
- ☐ 9. Measure and record the temperature of the heated water immediately.
Heated water temp: _____
- ☐ 10. Subtract the initial water temperature from the heated water temperature.
Heated water temp _____
Subtract initial water temp _____
Result _____
- ☐ 11. Checks for a minimum temperature rise between 6°C to 7.6°C or 10.8°F to 13.5°F, and if the result Step 10 is above the minimum, move on to Step 13.
- ☐ 12. If the temperature rise is less than the minimum:
 - a. Make additional tests to assure that variations or errors in the test procedure did not account for the unacceptable reading.
 - b. Use standard test procedures to assure that supply voltage is a minimum of 115V AC.
- ☐ 13. Multiply the temperature rise in Step 10 by a factor of 70 to determine the power output in watts.
- ☐ 14. Have your instructor check your work.
- ☐ 15. Continue troubleshooting as directed by your instructor if temperature rise is below the minimum of 6°C.
- ☐ 16. Clean up area and return tools and materials to proper storage.

Comments: _____

**Microwave Ovens
Unit 14****Job Sheet 9—Test and Replace High Voltage Components When an Oven Produces
Little or No Heat**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Capacitor safely discharged as routines require	_____
Capacitor checked and replaced as needed	_____
Diode checked and replaced as needed	_____
Magnetron checked and replaced as needed	_____
Power transformer checked and replaced as needed	_____

A. Tools and materials

Microwave oven, Litton model 1304, 1305, 1420, or 1422
Service manual for microwave oven
Ohmmeter with a range of $R \times 10,000$ or greater
9V battery
Screwdriver w/insulated handle or resistor for discharging capacitor
Standard appliance repair tools
Pencil and paper
Safety glasses

B. Procedure

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- ☐ 1. Remove all jewelry and put on safety glasses.
- ☐ 2. Discharge the capacitor.
- ☐ 3. Set the ohmmeter on its highest resistance scale.

Note: The following test will not work if a capacitor has a built-in bleed resistor; that type of capacitor should be checked with a capacitor analyzer.

Job Sheet 9

- ☐ 4. Remove wires from the capacitor terminals and connect the ohmmeter leads to the capacitor terminals.
- ☐ 5. Check the meter to make sure it momentarily deflects toward zero and then returns to infinity.
 - a. If no deflection occurs, replace the capacitor.
 - b. If continuous deflection occurs, replace the capacitor.
- ☐ 6. Check between the terminal and the case for infinite resistance, and if it is not present, replace the capacitor.
- ☐ 7. Have your instructor check your work.

C. Routine 2—Test the diode

- ☐ 1. Discharge the capacitor.
- ☐ 2. Set the ohmmeter to its highest resistance scale.
- ☐ 3. Remove the leads that come from the capacitor and connect with the diode terminals.
- ☐ 4. Place the ohmmeter leads on the diode terminals.
- ☐ 5. Check for infinite resistance of either 50,000 or 200,000 ohms and record your finding: _____.

Note: Other oven models may present different readings.

- ☐ 6. Reverse the ohmmeter leads on the diode terminals and check for either 50,000 or 200,000 ohm on the second testing and record your finding: _____.

Note: If the first reading was 50,000, the second reading should be 200,000, or if 200,000 on the first reading, 50,000 on the second reading.

- ☐ 7. Replace the diode if it fails to pass the infinite resistance test.
- ☐ 8. Have your instructor check your work.

D. Routine 3—Test the magnetron

- ☐ 1. Discharge the capacitor.
- ☐ 2. Remove the leads to the magnetron and connect the ohmmeter to the terminals.

Job Sheet 9

- ☐ 3. Check for a reading of less than 1 ohm between terminals.
- ☐ 4. Set the VOM at the highest scale to check infinite resistance between each magnetron terminal and ground.
- ☐ 5. If the test is not conclusive and if all other components check okay and the oven still does not heat, replace the magnetron.

Note: Magnetron replacement is detailed in the next job sheet.

- ☐ 6. Have your instructor check your work.

E. Routine 4—Test the power transformer

- ☐ 1. Discharge the capacitor.
- ☐ 2. Check primary winding first by removing wires from the terminals marked 1 and 2 and connecting the ohmmeter leads to those terminals and recording your findings: T1 _____ T2 _____
- ☐ 3. Check between the terminal and ground:
 - a. On all three types of transformers, the primary winding check should read less than 1 ohm.
 - b. On all three types of transformers, the terminal to ground should read infinite resistance
- ☐ 4. Check high voltage winding next by removing the wire from the secondary terminal marked HV.
- ☐ 5. Connect ohmmeter leads between the HV terminal and oven chassis:
 - a. HV to ground on a Type 1 transformer should read 54 to 64 ohms.
 - b. H1 to ground on a Type 2 transformer should read 66 to 74 ohms, and LO to ground on a Type 2 transformer should read 63 to 71 ohms.
- ☐ 6. Record all findings: _____

- ☐ 7. Check the filament winding next by removing wires 3 and 4 on the transformer and connecting the ohmmeter between those terminals; the reading should be less than one 1 ohm.

Reading: _____

Job Sheet 9

- ☐ 8. Check between each filament terminal to ground; the reading should show infinite resistance.

Readings: _____

- ☐ 9. Replace power transformer if readings indicate problems.
- ☐ 10. Have your instructor check your work.
- ☐ 11. Clean up area and return tools and materials to proper storage.

Comments: _____

**Microwave Ovens
Unit 14****Job Sheet 10—Remove a Blower Motor and Transformer and Remove and Reinstall a Magnetron**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Capacitor safely discharged	_____
Blower motor, housing duct, transformer, and diode removed	_____
Magnetron removed and reinstalled	_____
Blower assembly reinstalled	_____
RF leak test completed and oven checked for proper operation	_____

A. Tools and materials

Microwave oven, Litton model 1304, 1305, 1420, or 1422
Service manual for microwave oven
Standard appliance repair tools
Screwdriver w/insulated handle or resistor to discharge capacitor
RF test instrument, probe and spacer cone
Replacement components as required
Safety glasses

B. Routine 1—Remove the blower and transformer

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- ☐ 1. Remove all jewelry and put on safety glasses.

Note: Removing the blower motor and transformer is required in order to access the magnetron. See the accompanying pictorial for visual assistance.

- ☐ 2. Unplug the power cord and remove access panel.

Job Sheet 10

- ☐ 3. Discharge the capacitor.
- ☐ 4. Remove the magnetron support.
- ☐ 5. Remove the blower housing duct.
- ☐ 6. Remove the blower motor mounting screw.
- ☐ 7. Disconnect leads and remove blower for inspection.
- ☐ 8. Have your instructor check your work.
- ☐ 9. Disconnect wires and remove the capacitor.
- ☐ 10. Disconnect transformer leads.
- ☐ 11. Remove transformer mounting hardware.
- ☐ 12. Lift transformer up to clear base and remove it.

Note: To replace the transformer, simply reverse the procedure.

- ☐ 13. Have your instructor check your work.

C. Routine 2—Remove and reinstall a magnetron

- ☐ 1. Remove the blower motor and diode as previously outlined.
- ☐ 2. Remove the magnetron mounting screws and lower the magnetron to remove it.
- ☐ 3. Check the magnetron RF gasket to be sure it is in good shape and properly placed before you reinstall the magnetron.
- ☐ 4. Reinstall the magnetron, tighten the mounting nuts, and check for secure and even alignment of the magnetron.
- ☐ 5. Reinstall the magnetron duct and thermo protector.
- ☐ 6. Reinstall the high voltage transformer and reconnect magnetron filaments leads and transformer leads.
- ☐ 7. Reinstall the diode.

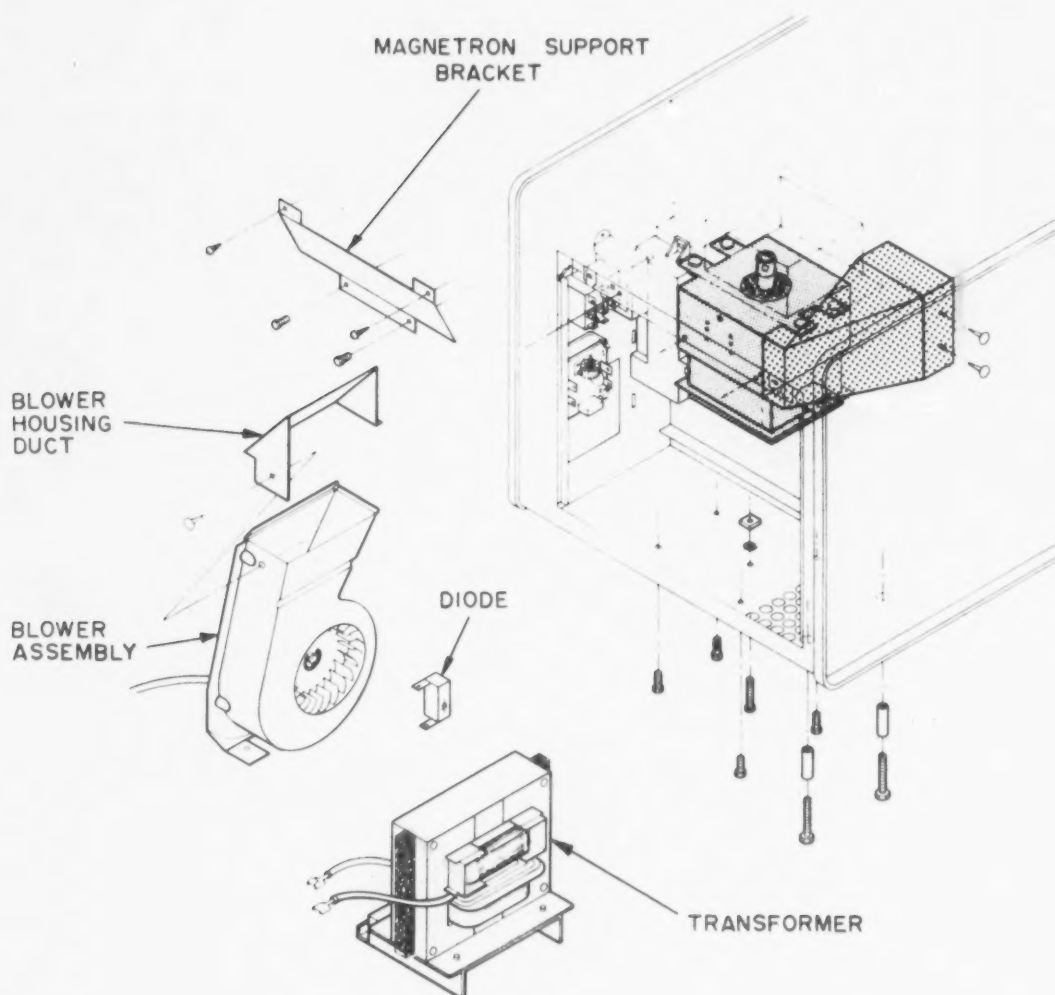
Job Sheet 10

- ☐ 8. Reinstall the blower, blower housing duct, and magnetron support bracket.
- ☐ 9. Have your instructor check your work.
- ☐ 10. Place a container of cool water in the oven cavity and check the oven for proper operation.
- ☐ 11. Check the oven for RF leakage with an approved RF test meter; use procedure outlined in a previous job sheet.
- ☐ 12. Record any problems or questions.

- ☐ 13. Have your instructor check your work.
- ☐ 14. Clean up area and return tools and materials to proper storage.

Comments: _____

Blower, Transformer, and Magnetron Pictorial
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Microwave Ovens
Unit 14

MAR-591

Job Sheet 11—Test the Interlock Switch Module on a Microwave Oven

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Capacitor safely discharged	_____
Continuity checked per Function Test Chart	_____
Findings recorded and evaluated	_____

A. Tools and materials

Microwave oven, Litton model 1304, 1305, 1420, or 1422
Service manual for microwave oven
Screwdriver w/insulated handle or resistor to discharge capacitor
Ohmmeter
Pencil and paper
Safety glasses

B. Procedure

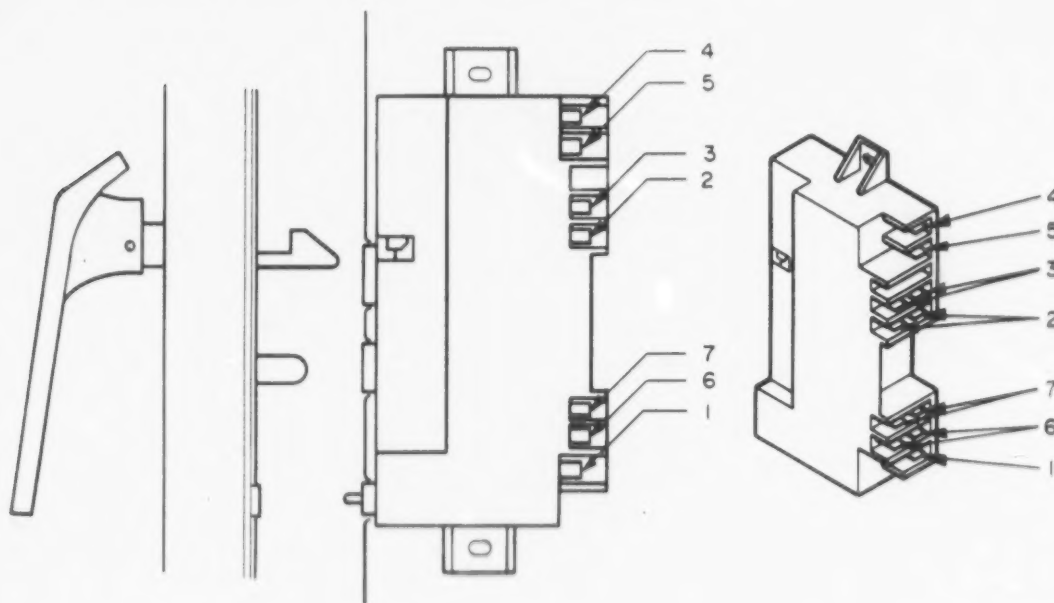
The following procedures and illustrations are adapted from materials copyrighted © by Litton Systems, Inc., and are reprinted with permission. Any other use is prohibited.

- ☐ 1. Remove all jewelry and put on safety glasses.
- ☐ 2. Unplug the power cord and remove the access panel.
- ☐ 3. Discharge the capacitor.
- ☐ 4. Check continuity between terminals with an ohmmeter according to the Function Test Chart that follows.

● Indicates Contacts Made	Primary Interlock		Secondary Interlock	Interlock Monitor	Door Sense
Function Terminals	2-3	1-3	6-7	1-6	4-5
Door Open	●			●	
Door Closed		●	●		●

Job Sheet 11

- ☐ 5. Use the reference points shown in the following pictorial to assure that your ohmmeter probes are on the proper terminals.



- ☐ 6. Record your findings.
- _____
- _____
- _____
- ☐ 7. If readings are correct, check the door latch for proper switch activation.
- ☐ 8. If door latch is okay, but switching is not okay, replace the Interlock Switch Module.
- ☐ 9. Have your instructor check your work.
- ☐ 10. Clean up area and return tools and materials to proper storage.

Comments: _____

**Microwave Ovens
Unit 14****Job Sheet 12—Test and Replace Magnetron and Cavity Thermal Protectors**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Capacitor safely discharged	_____
Magnetron and cavity thermal protectors accessed and tested	_____
Magnetron and cavity thermal protectors replaced as required	_____

A. Tools and materials

Microwave oven, Litton model 1304, 1305, 1420, or 1422

Service manual for microwave oven

Screwdriver w/insulated handle or resistor to discharge capacitor

RF test instrument, probe and spacer cone

Standard appliance repair tools

Replacement thermal protectors for cavity and magnetron

Safety glasses

B. Procedure

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- ☐ 1. Remove all jewelry and put on safety glasses.
- ☐ 2. Unplug the power cord and remove the access panel.
- ☐ 3. Discharge the capacitor.

Note: Refer to the schematic and pictorial that accompanies this job sheet as you complete this activity.

- ☐ 4. Disconnect the #25 wire from the fuse block.

Job Sheet 12

- ☐ 5. Perform a continuity test from #25 wire to #1 wire:
 - a. If continuity test indicates a closed circuit, both thermal protectors are okay and no further testing is necessary.
 - b. If continuity test indicates an open circuit, complete the procedure to determine which thermal protector is open.
- ☐ 6. Cut #24 wire between the cavity thermal protector and the magnetron thermal protector.
- ☐ 7. Perform a continuity test using the following chart as a guide.

TEST POINTS	
Magnetron T. P.	Wire #1 - Wire #24 (Magnetron side)
Cavity T.P.	Wire #25 - Wire #24 (Cavity side)

- ☐ 8. If continuity test indicates an open circuit, replace the defective thermal protector as outlined later in this job sheet.
- ☐ 9. Make a check also for a stalled blower or an obstruction in the magnetron cooling air flow, or an overheat condition in the oven cavity.
- ☐ 10. Record your findings.

- ☐ 11. Have your instructor check your work.
- ☐ 12. Remove magnetron and cavity thermal protectors with the following procedure:
 - a. Remove the wire cover and rear exhaust duct on the back of the oven to expose the cavity thermal protector.
 - b. Remove the cavity thermal protector.
 - c. Remove the clamp holding the magnetron thermal protector.
 - d. Inspect both protectors, check for continuity, and replace as required.

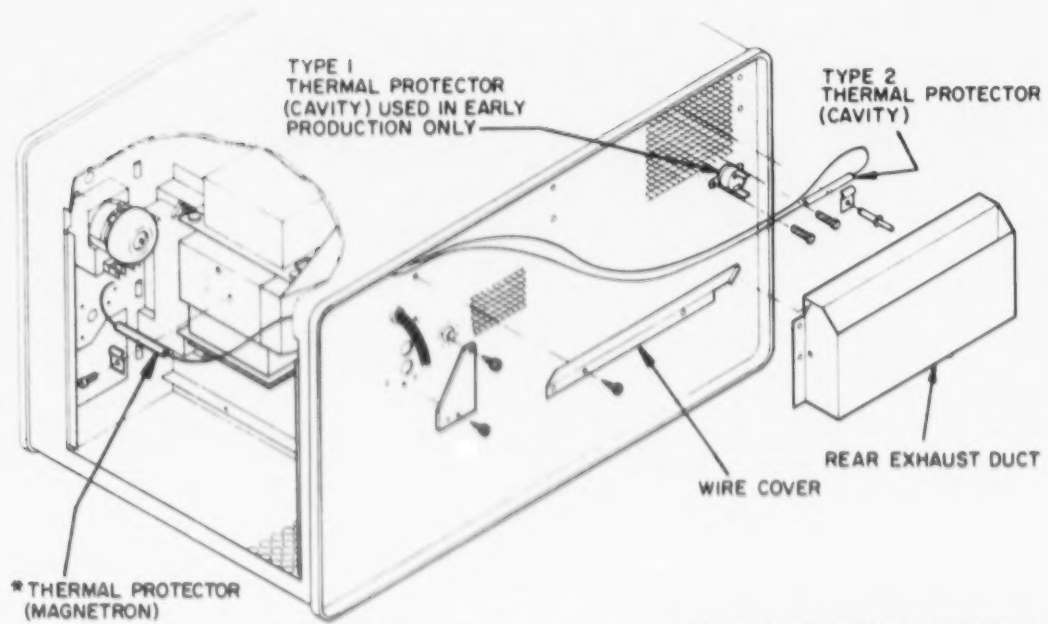
Job Sheet 12

- ☐ 13. Reverse the previous procedure to install replacement thermal protectors.
- ☐ 14. Have your instructor check your work.
- ☐ 15. Clean up area and return tools and materials to proper storage.

Comments: _____

Job Sheet 12

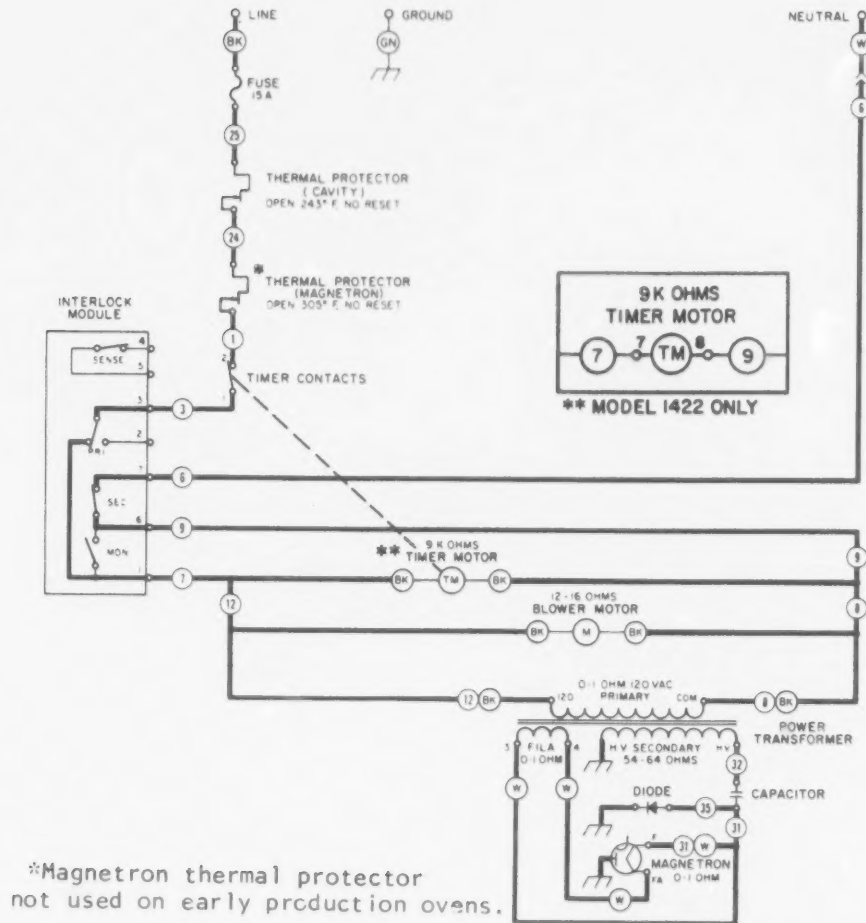
Thermal Protectors Pictorial
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*MAGNETRON THERMAL PROTECTOR
NOT USED ON EARLY PRODUCTION
OVENS.

Conditional Schematic—COOK Condition
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CONDITIONAL SCHEMATIC - COOK CONDITION



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**Microwave Ovens
Unit 14**

MAR-601

**Job Sheet 13—Test and Replace a Low Voltage Transformer
and a Triac Module**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Capacitor safely discharged	_____
Low voltage transformer access and checked	_____
Triac module accessed and checked for short	_____
Triac module checked for open	_____
Low voltage transformer and triac removed and/or replaced	_____

A. Tools and materials

Microwave oven, Litton model 1304, 1305, 1420, or 1422
Service manual for microwave oven
Screwdriver w/insulated handle or resistor to discharge capacitor
VOM
Replacement low voltage transformer and triac as required
Safety glasses

B. Routine 1—Test a low voltage transformer

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- ☐ 1. Remove all jewelry and put on safety glasses.
- ☐ 2. Unplug the power cord and remove the access panel.
- ☐ 3. Discharge the capacitor.
- ☐ 4. Set the voltmeter for the appropriate VAC scale and perform the test set-ups as indicated in the following Test Procedure Chart.

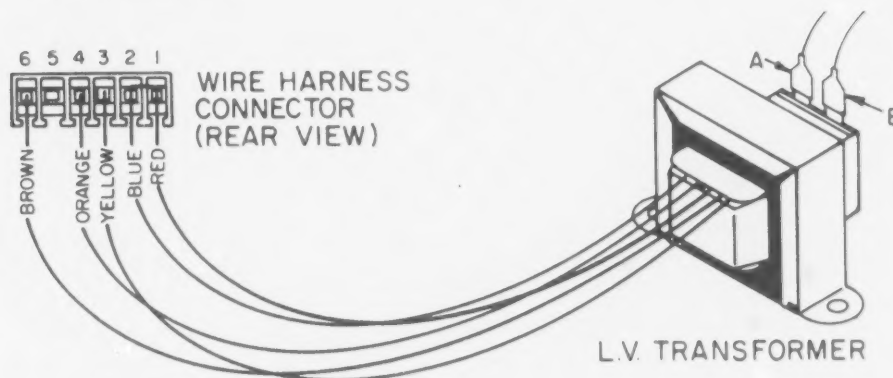
Job Sheet 13

Test Procedure Chart

Caution: Do not touch any oven components or wiring during oven operation.

Test Set-Ups	Test Points	Normal Voltage (Approximate)
Attach meter leads to wire harness test points A-B, apply power to oven and open oven door.	A & B	120 VAC (Line Voltage)
Disconnect power and remove L.V. transformer connector attached to the control circuit board and attach meter leads into harness side of connector at test points shown in chart. Apply power to oven and open oven door.	2(Blue)-3(Yellow)	2.5 VAC
	1(Red)-6(Brown)	20 VAC
	1(Red)-4(Orange)	20 VAC

- 5. Reference the following illustration to make sure your leads are connected to the proper terminals.



- 6. Record your findings:
- If the proper AC voltages were measured, the low voltage transformer operation is normal.
 - If an abnormal reading was measured at test points 2-3, 1-8, and 1-4, but normal voltage was measured at test points A-B, the low voltage transformer should be replaced.

Job Sheet 13

- c. If no voltage was measured at test points A-B, check wire connections and perform a circuit diagnosis for other possible causes.

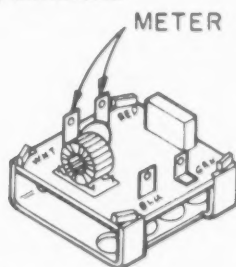
- ☐ 7. Have your instructor check your work.

C. Routine 2—Test for a shorted triac when oven heats only on HIGH

- ☐ 1. Remove the harness leads from the triac module.

Note: Remember, this test is needed only when oven heats only on HIGH.

- ☐ 2. Set the ohmmeter on the R x 1 scale and attach the test leads across the WHT (MT1) and RED (MT2) terminals.



- ☐ 3. Record your findings:

- a. A reading of infinity is normal and the triac is okay.
b. If the reading is abnormal, replace the triac module.

- ☐ 4. Reverse test leads and repeat the procedure.
☐ 5. Record your findings.
-
-

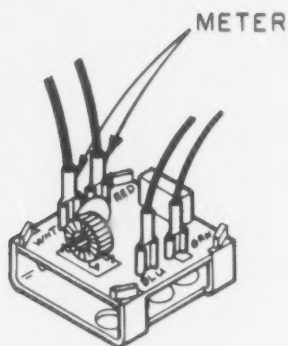
- ☐ 6. Have your instructor check your work.

D. Routine 3—Test for an open triac on an oven that does not heat at all

- ☐ 1. Discharge the capacitor.
☐ 2. Remove completely the high voltage lead marked HV that connects the capacitor to one of the transformer high voltage terminals.
☐ 3. Make sure the VOM is capable of reading 120V AC.

Job Sheet 13

- ☐ 4. Keep triac leads attached and use alligator clips to attach the meter leads to triac terminals WHT (MT1) and RED (MT2).



- ☐ 5. Use alligator clips to make the following operational checks, and pay careful attention at every step because:
- a. DANGEROUS high voltages are present at the high voltage secondary terminals during a COOK cycle.
 - b. DO NOT TOUCH any oven components or wiring during oven operation.
- ☐ 6. Stop here and check with your instructor; the remainder of this procedure should be completed only in the presence and under the supervision of your instructor.
- ☐ 7. Plug the power cord in and energize the oven in the COOK condition.
- ☐ 8. Measure and record the voltage indicated on the meter: _____.
- ☐ 9. Disconnect power to the oven.
- ☐ 10. Evaluate your findings:
- a. If a normal indication of less than 5V AC was indicated, the triac module is okay.
 - b. If an abnormal reading was indicated and the electronic control circuit board triac drive test was okay, replace the triac module.

Job Sheet 13

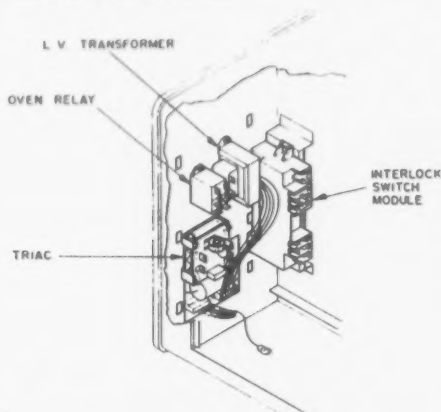
- c. If an abnormal condition still exists, reinstall the old triac module, replace the electronic control circuit board, and retest.

- ☐ 11. Record retest findings.

- ☐ 12. Have your instructor check your work.

E. Routine 4—Remove a low voltage transformer and a triac

- ☐ 1. Discharge the capacitor.
- ☐ 2. Remove the blower motor and control panel as outlined in a previous job sheet.
- ☐ 3. Remove the mounting screws or bolts for the transformer, remove transformer leads, and remove the transformer.



- ☐ 4. Remove the mounting screws or bolts for the triac, remove the triac leads, and remove the triac.
- ☐ 5. Have your instructor check your work.
- ☐ 6. Replace the low voltage transformer and triac as directed.
- ☐ 7. Clean up area, return tools and materials to proper storage, and dispose of old parts per standard procedure.

Comments: _____

Microwave Ovens
Unit 14

MAR-607

Job Sheet 14—Test a Temperature Probe and Probe Jack

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Capacitor safely discharged	_____
Temperature probe and probe jack accessed and tested	_____
Probe and probe jack replaced as testing required	_____

A. Tools and materials

Microwave oven, Litton model 1320, 1325, 1335, or 1450

Service manual for microwave oven

Screwdriver w/insulated handle or resistor to discharge capacitor

VOM

Beaker or container for water and hot water supply

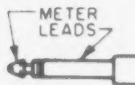
Replacement probe and probe jack as required

Safety glasses

B. Routine 1—Test the temperature probe

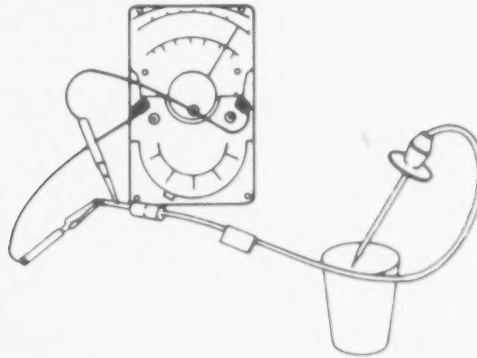
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- ☐ 1. Remove all jewelry and put on safety glasses.
- ☐ 2. Set the VOM to a scale capable of reading 100,000 ohms.
- ☐ 3. Connect the meter leads to the temperature probe as indicated below and record your finding: _____



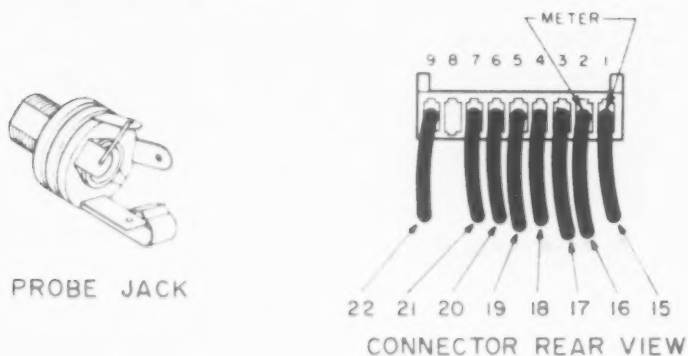
Job Sheet 14

- a. If resistance indicated is approximately 30,000 to 75,000 ohms at room temperature, go on to Step 4.
 - b. If infinite resistance or extremely low resistance is indicated, replace the temperature probe and check the oven for proper operation.
- ☐ 4. Pour hot water into a container, leave the leads connected to the probe, and immerse the tip of the probe in the container of hot water.

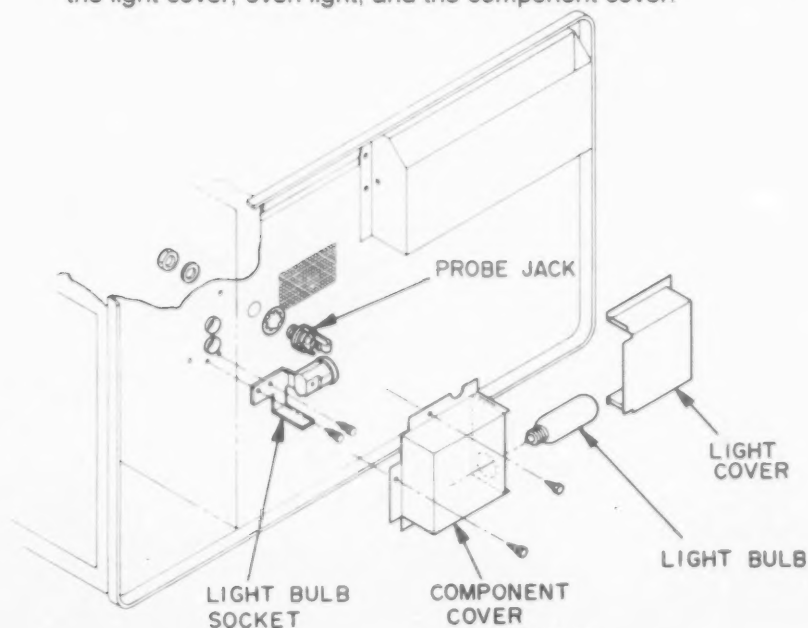


- a. If the resistance increased with the probe immersed in hot water, go on to the next probe jack test.
 - b. If the resistance did not decrease with the probe immersed in hot water, replace the temperature probe.
- ☐ 5. Record your findings.
- _____
- _____
- _____
- ☐ 6. Have your instructor check your work.
- C. Routine 2—Test the probe jack
- ☐ 1. Unplug the power cord and remove the access panel.
 - ☐ 2. Discharge the capacitor.

- 3. Locate the probe jack at the rear of the oven cavity and the point where it connects to the circuit board connector.



- 4. Remove the harness from the electronic control circuit board assembly.
- 5. Set the VOM to the R x 1 scale and connect the meter leads into the harness side of the connector contacts as shown in the following illustration.
- With the probe removed from the jack, the meter should read, approximately zero ohms.
 - With the VOM set to the highest resistance scale and the probe plugged into the probe jack, the meter should read approximately 30,000 to 75,000 ohms at room temperature.
 - If either reading is significantly off, replace the probe jack by removing the light cover, oven light, and the component cover.



Job Sheet 14

- ☐ 6. Record your findings.

- ☐ 7. Have your instructor check your work.

- ☐ 8. Clean up area and return tools and materials to proper storage.

Comments:

**Microwave Ovens
Unit 14****Job Sheet 15—Test and Replace an Oven Timer
and an Oven Controller**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Capacitor safely discharged	_____
Oven timer tested	_____
Controller tested	_____
Oven timer and controller removed/replaced	_____

A. Tools and materials

Microwave oven, Litton model 1304, 1305, 1320, and 1325
Service manual for microwave oven
Screwdriver w/insulated handle or resistor to discharge capacitor
VOM
Replacement timer and controller as required
Safety glasses

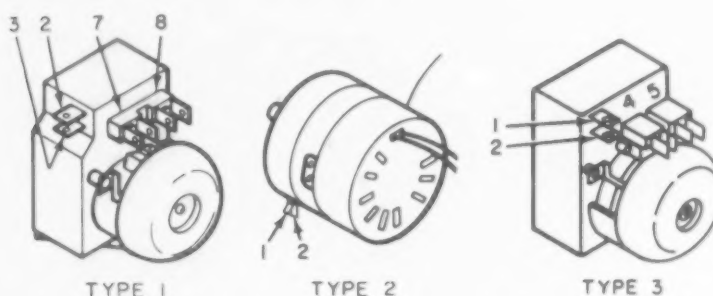
B. Procedure

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- ☐ 1. Remove all jewelry and put on safety glasses.
- ☐ 2. Unplug the power cord and remove the access panel.
- ☐ 3. Discharge the capacitor.

Job Sheet 15

- ☐ 4. Disconnect wire leads from the timer switch terminals according to type.



- ☐ 5. Check continuity between terminals according to the following chart.

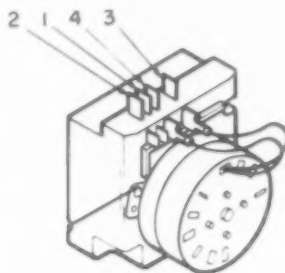
● INDICATES CONTACTS MADE	OVEN TIMER TYPE 1	OVEN TIMER TYPE 2 & 3
CONTACTS FUNCTION	2-3	1-2
TIMER OFF		
TIMER ON	●	●

- ☐ 6. Check to see that the timer operates with 120V AC applied to appropriate motor terminals:
- Type 1 timer, terminals 7 and 8
 - Type 2 timers, motor terminals
 - Type 3 timers, terminals 4 and 5
- ☐ 7. Record your findings.
- _____
- _____
- _____
- ☐ 8. Replace the timer if it fails to operate on proper voltage application; the replacement routine is presented later in this job sheet.
- ☐ 9. Have your instructor check your work.

Job Sheet 15

C. Routine 2—Test a controller

- ☐ 1. Discharge the capacitor.
- ☐ 2. Disconnect the leads from the controller terminals #2 and #4.



Caution: Because of high voltage AC at the high voltage terminal of the power transformer during a cook cycle, conduct the next procedure **ONLY IN THE PRESENCE AND UNDER THE GUIDANCE OF YOUR INSTRUCTOR.**

- ☐ 3. Connect terminals #2 and #4 together with an in-line connector or a jumper wire.
- ☐ 4. Set the oven at full power and conduct an operation test to determine if the oven is operating normally:
 - a. if the oven operates normally with the controller bypassed, replace the controller and test the oven again; the replacement procedure is presented later in this job sheet.
 - b. if an abnormal condition still exists with the controller bypassed, conduct a circuit diagnosis to determine other causes.
- ☐ 5. Leave jumper wire in place and record your findings.

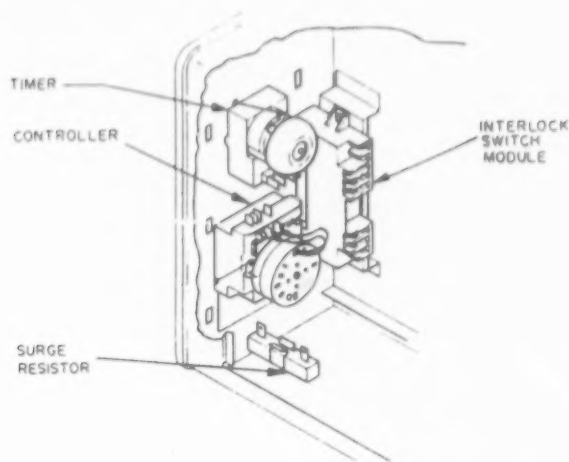
- ☐ 6. Have your instructor check your work.

D. Routine 3—Remove and replace a timer and a controller

- ☐ 1. Continue from previous routine, and remove the jumper wire and replace the controller leads to terminals #2 and #4.
- ☐ 2. Unplug the microwave.

Job Sheet 15

- ☐ 3. Discharge the capacitor.
- ☐ 4. Remove the blower motor and control panel as shown in a previous job sheet.
- ☐ 5. Remove the timer mounting screws or bolts.
- ☐ 6. Remove the timer for inspection.



- ☐ 7. Remove the controller mounting screws or bolts.
- ☐ 8. Remove the controller for inspection.
- ☐ 9. Inspect timer and controller for visual evidence of wear or malfunction.
- ☐ 10. Have your instructor check your work.
- ☐ 11. Replace timer and controller as directed.
- ☐ 12. Replace access panel, plug oven in, and run a test for proper operation.
- ☐ 13. Have your instructor check your work.
- ☐ 14. Clean up area and return tools and materials to proper storage; dispose of old parts according to standard procedure.

Comments: _____

Microwave Ovens
Unit 14

MAR-613

Job Sheet 16—Remove, Test, and Replace a Control Panel

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Capacitor safely discharged	_____
Control panel properly removed	_____
Touch panel tested and replaced as required	_____

A. Tools and materials

Microwave oven, Litton model 1304, 1305, 1420, or 1422
Service manual for microwave oven
Screwdriver w/insulated handle or resistor to discharge capacitor
VOM
Standard appliance repair tools
Utility knife such as an X-acto
Timer or watch w/second hand
Safety glasses

B. Routine 1—Remove the control panel

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- ☐ 1. Remove all jewelry and put on safety glasses.
- ☐ 2. Unplug the power cord and remove the access panel.
- ☐ 3. Discharge the capacitor.
- ☐ 4. Insert a flat-blade screwdriver between the side of the oven and the control panel mounting tabs and push inward to disengage the tabs; see the pictorial that accompanies this job sheet.

Note: Some models have a nylon spacer that has to be squeezed together and pulled away from the cavity.

- ☐ 5. Swing the control panel away from the oven, using the left side tabs as pivots; then disengage the left side tabs.
- ☐ 6. Pull the control panel about two inches forward and disconnect the component wires.
- ☐ 7. Remove the panel for testing.
- ☐ 8. Have your instructor check your work.

C. Routine 2—Test the control panel

- ☐ 1. Read the following **CAUTIONS** before continuing this routine;
 - a. Do not over-flex the ribbon cable or you will damage it.
 - b. Do not use pointed test leads on a ribbon cable because the leads will damage the silver circuit.
 - c. Do not scratch the ribbon cable or you will damage the circuit.
 - d. Do not touch any part of the circuitry on the back of the electronic control circuit board assembly because static discharge can damage the circuit board.
 - e. Do not bend the ribbon cable forward.
- ☐ 2. Disconnect the ribbon cable from the circuit board by applying even pressure to both sides of the ribbon cable and pulling outward from the ribbon cable connector.
- ☐ 3. Touch ohmmeter test leads to the ribbon cable test points indicated in the pictorial that accompanies this job sheet.
- ☐ 4. Check for a reading of 1 meg ohms between the ribbon cable test points while the touch panel pad is depressed.
- ☐ 5. Depress any touch panel pad and check for a resistance reading of less than 100 ohms between the connecting test points:
 - a. if improper readings appear, run the test again.
 - b. if improper readings appear a second time, replace the defective touch panel assembly.
- ☐ 6. Inspect the ribbon cable silver circuit, and if any silver is missing from the connector end of the ribbon cable; see the pictorial that accompanies this job sheet.

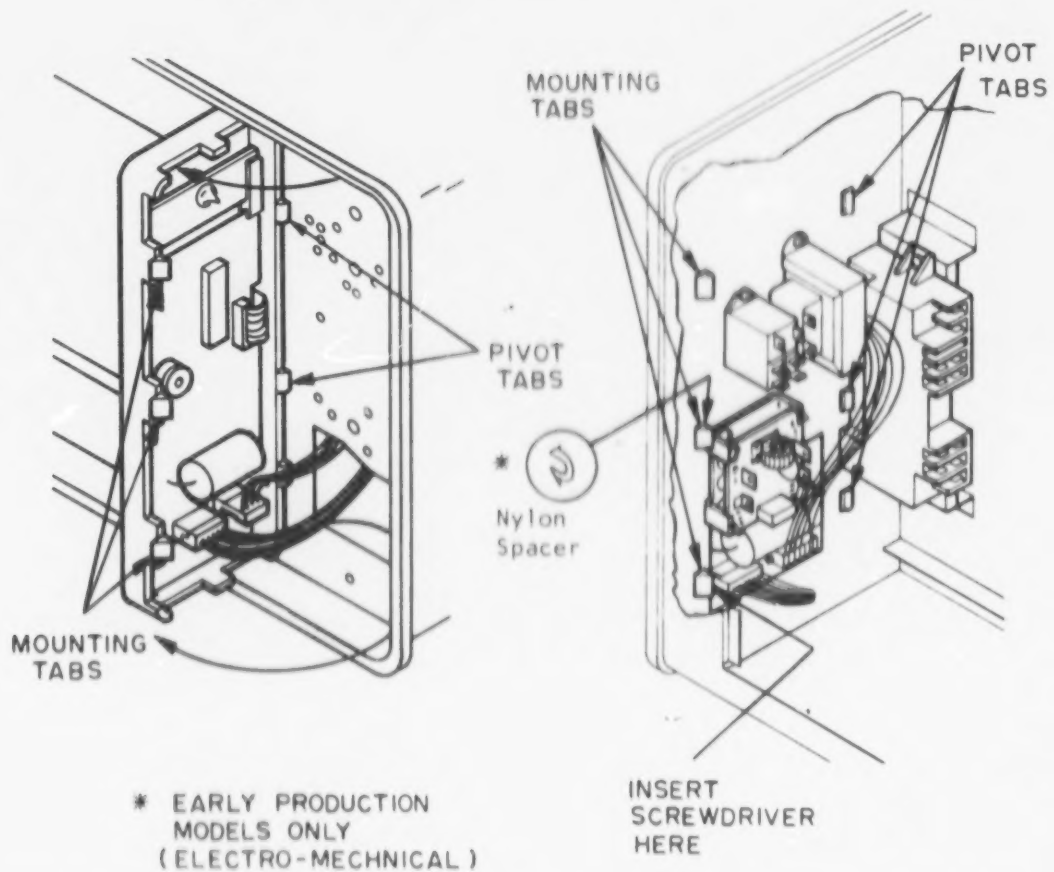
Job Sheet 16

- ☐ 7. Reinsert the ribbon cable into the connector by applying even pressure to both sides of the ribbon cable and gently pressing down.
- ☐ 8. Have your instructor check your work.
- ☐ 9. Clean up area and return tools and materials to proper storage.

Comments: _____

Control Panel

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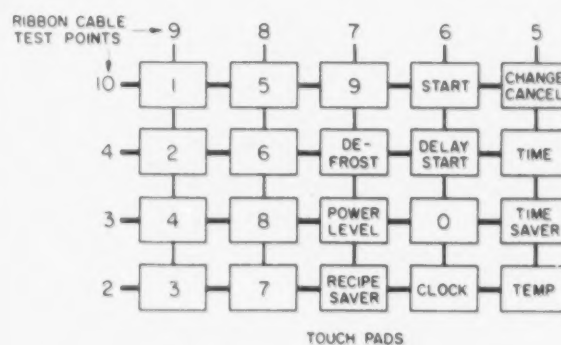
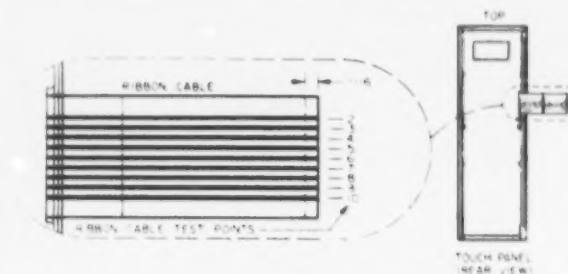


Job Sheet 16

Control Panel

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All touch panel models and revision levels apply.



NOTE: CERTAIN FEATURES ARE AVAILABLE ONLY ON SOME MODELS

**Microwave Ovens
Unit 14****Job Sheet 17—Test a Control Circuit Board**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Capacitor safely discharged	_____
Self diagnostic test completed	_____
Trouble areas noted	_____

A. Tools and materials

Microwave oven, Litton model 1304, 1305, 1440, or 1450
Service manual for microwave oven
Pencil or pen
Safety glasses

B. Procedure

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- ☐ 1. Put on safety glasses.
- ☐ 2. Reference the self diagnostic flow chart that accompanies this job sheet and follow all directions to complete the self test.
- ☐ 3. Make notes as required if you confront any trouble with the test, and record your findings on the back of this page.
- ☐ 4. Have your instructor check your work.
- ☐ 5. Clean up area as needed.

Comments: _____

Job Sheet 17

Self Diagnostic Problems

Microwave oven serial # _____

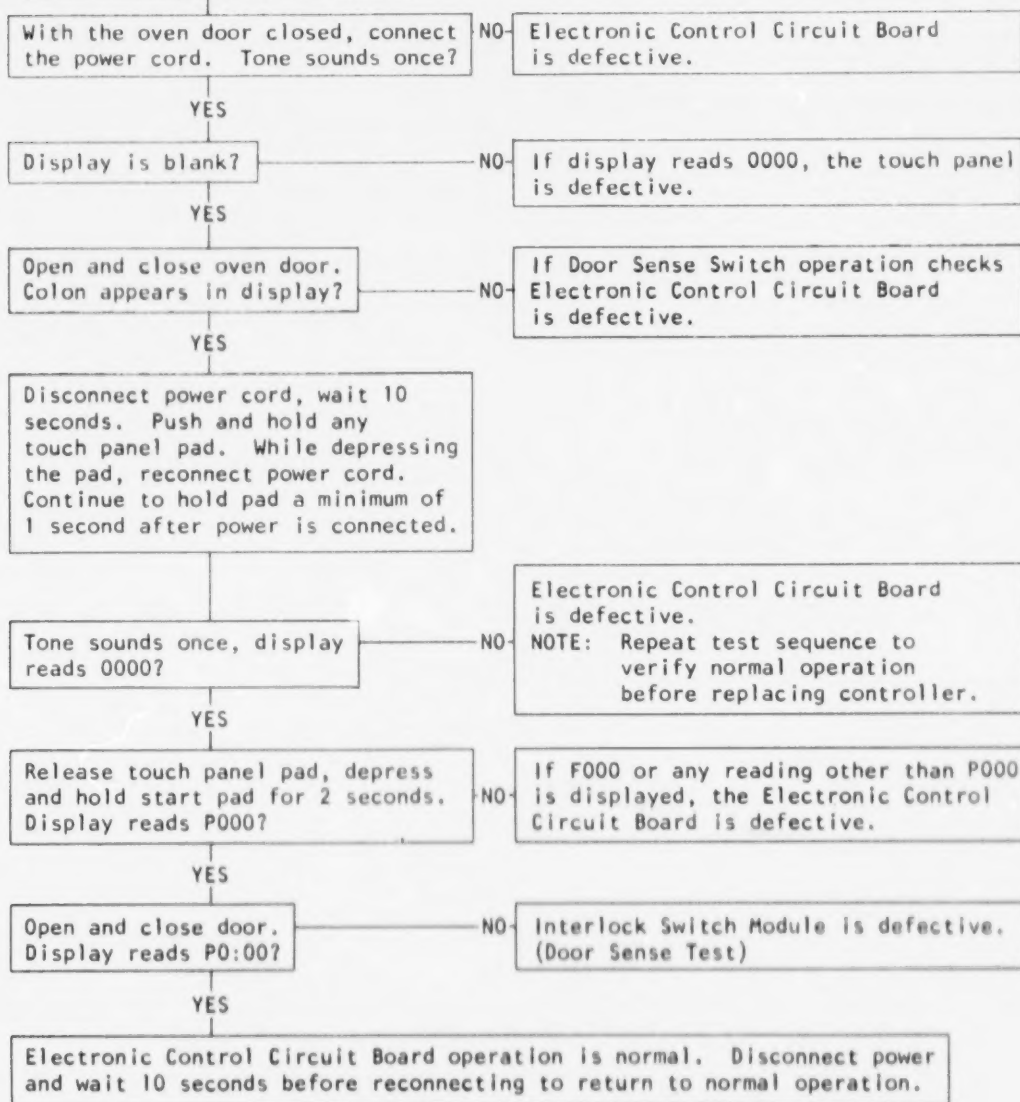
Date test made _____

Problems noted and points in test where they occurred

Include any comments below:

Job Sheet 17

Self Diagnostic Problems
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SELF DIAGNOSTIC TEST SEQUENCE

**Microwave Ovens
Unit 14**

Job Sheet 18—Test a Cook Relay

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Capacitor safely discharged	_____
Test set-ups completed per specifications	_____
Findings recorded	_____

A. Tools and materials

Microwave oven, Litton model 1320, 1325, 1440, or 1450
 Service manual for microwave oven
 Screwdriver w/insulated handle or resistor to discharge capacitor
 VOM
 Standard appliance repair tools
 Electrical tape
 Safety glasses

B. Procedure

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- ☐ 1. Remove all jewelry and put on safety glasses.
- ☐ 2. Unplug the power cord and remove the access panel.
- ☐ 3. Discharge the capacitor.

Caution: Complete the remainder of this procedure only in the presence and with the supervision of your instructor.

- ☐ 4. Perform test set-ups indicated in the Test Chart that accompanies this job sheet.

Job Sheet 18

- ☐ 5. Pay special attention to the following as you complete test procedures:
 - a. Do not touch components or wiring during operational tests.
 - b. Before touching oven components or wiring, always discharge the capacitor.
- ☐ 6. Complete test per specifications and record your findings; be sure to note any problems.

- ☐ 7. Have your instructor check your work.
- ☐ 8. Clean up area and return tools and equipment to proper storage.

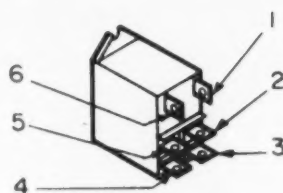
Comments: _____

Job Sheet 18

Test Chart

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Test Set-Up	Terminal Test Point	Normal Reading	Corrective Action for Abnormal Reading
Disconnect power. Remove harness leads from relay terminals 1 & 6. Set meter to R x 1 ohm scale.	1 to 6	250 to 350 ohms	If abnormal reading is measured, replace the relay and retest.
Reconnect harness leads to terminals 1 & 6. Remove harness leads from terminals 2, 3, 4, and 5 and insulate to prevent electrical short.	2 to 3 4 to 5	Infinite Infinite	If wire connections and incoming line voltage check OK, replace relay and retest.
Reconnect power. Program oven for 15 seconds and put oven into a COOK cycle.	2 to 3 4 to 5	Less than 1 ohm during cook, then infinite at the end of the COOK cycle.	If electronic controller oven relay drive checks OK, replace relay and retest.



OVEN RELAY

**Microwave Ovens
Unit 14****Job Sheet 19—Test and Replace a Turntable Motor**

Name _____ Attempt Number _____

Date _____ Overall Rating _____

Evaluation Criteria	Rating
Initial test completed	_____
Capacitor safely discharged	_____
Turntable tested and/or replaced as required	_____

A. Tools and materials

Microwave oven as selected by instructor
Service manual for microwave oven
Screwdriver w/insulated handle or resistor to discharge capacitor
VOM
Replacement turntable motor as required
Safety glasses

B. Procedure

- ☐ 1. Put on safety glasses.
- ☐ 2. Open oven door and remove turntable from spindle according to service manual.
- ☐ 3. Place a container with at least one cup of water in the microwave and test for normal operation.
- ☐ 4. If the turntable motor runs okay but the turntable does not revolve, inspect the spindle and turntable for wear and replace as required.
- ☐ 5. If turntable does not revolve, continue with troubleshooting.
- ☐ 6. Remove all jewelry.
- ☐ 7. Unplug the power cord and remove the access panel.
- ☐ 8. Discharge the capacitor.

Job Sheet 19

- ☐ 9. Turn the microwave upside down and remove the bottom panel to access the turntable motor.

Note: Access to the turntable motor will vary with type of microwave.

- ☐ 10. Use your VOM to test the turntable motor for continuity and other checks as specified in the service literature.
- ☐ 11. Have your instructor check your work.
- ☐ 12. If motor tests good, continue troubleshooting as directed by your instructor; you will probably have to perform a circuit analysis.
- ☐ 13. If turntable motor checked out bad, replace it.
- ☐ 14. Replace the bottom panel.
- ☐ 15. Replace the access panel.
- ☐ 16. Plug in the power cord and test the oven for normal operation and proper turntable rotation.
- ☐ 17. Have your instructor check your work.
- ☐ 18. Clean up area and return tools and materials to proper storage; dispose of old parts per standard procedure.

Comments: _____

